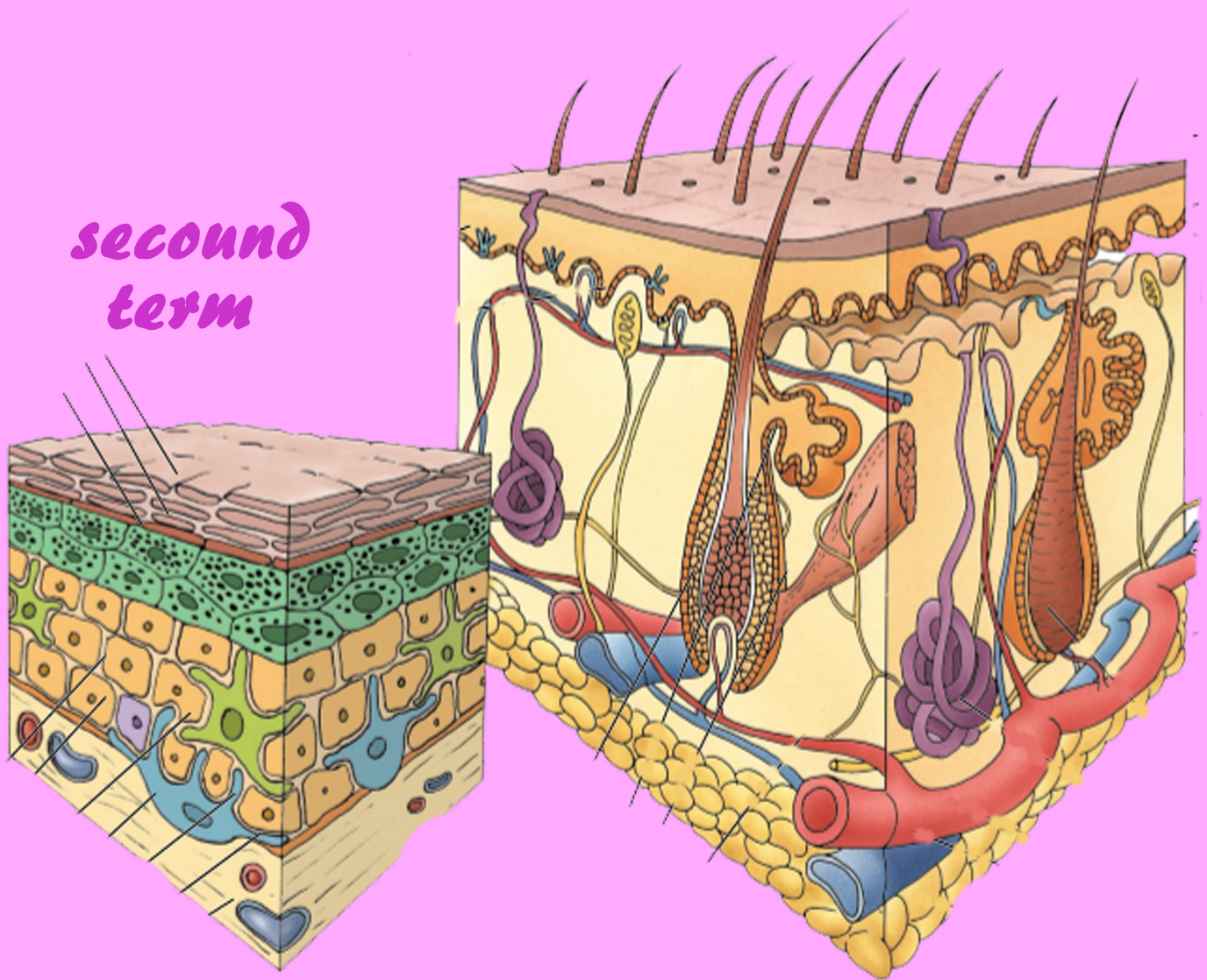


Histology

Dr. Gihan



by

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Bone

def.: A type of c.t. in w the matrix is hard & vascular.

Structure: Cells $\nwarrow$ + Fibres [collagen type I] + solid matrix
+ periosteum & endosteum [rich in Ca & phosphorus]

Functions:

- ① Form adult skeleton.
- ② support fleshy structures.
- ③ protect vital organs e.g. brain, heart, lungs & b.m.
- ④ reservoir for Ca

Shapes of bone: Anatomical classification

1. long bones.
2. short bones.
3. Flat bones.
4. Irregular bones

Types of bone: histological classification:

1. Compact (regular) bone
2. Spongy (irregular) bone.

Structure of Bone

Bone Matrix

matrix
cells

periosteum, endosteum

lamellae of calcified collagenous bundles separated by calcified ground substance.

1. **Organic Component: 35%:** secreted by bone cells
 - collagen type I: so, the matrix is acidophilic.
 - ground substance = proteoglycans [GAGs] & glycoproteins.

2. **Inorganic Component: 65%:**

Ca phosphate & carbonate. Ca salts appear as crystals on the surface of collagen bundles & in ground substance.

2 methods for preparing bone sections:

1. Decalcified compact bone:

Ca is removed (dissolved) by nitric A. 10% $\rightarrow$ soft tissue w can be cut & stained as usual. It demonstrates periosteum, endosteum, bone cells, b.m. cells & matrix.

2. Ground bone: [Grinding method]

bone is left to dry, cut into thin transparent slices using a saw & thinned by Carborandum wheel & examined unstained. By this method, dead cells or tissues are replaced by air w appears black. This method demonstrates: calcified bone lamellae, lacunae & canaliculi, Haversian Canals & Volkman's Canals. [Not used for spongy bone]

Osteoprogenitor cell

Bone Cells

	Osteogenic Cells	Osteoblasts ^[bone forming cells]	Osteocytes ^[mature bone cells]	Osteoclasts ^[bone destroyer]
Origin	U.MCs & pericytes	- Osteogenic cells	- Osteoblasts	Fusion of blood monocytes.
Site	Inner layer of periosteum & endosteum		imprisoned inside lacunae bet. bone lamellae & connected by canaliculi	In cavities called Howship's Lacuna on bony surfaces (near p.m.) cavity
L.M.	- small flat cell e' - flat dark nucleus & - pale basophilic cytoplasm.	- Oval branched cells e' few processes. ^{pale} - N: eccentric, rounded e' clear nucleolus. - C: deeply basophilic e' unstained area = -ve	- Small branched oval cells - N: central & oval. - C: pale basophilic - also contain alk. phosphatase.	- large cell e' brush border - multinucleated (6-12 nuclei) - C: foamy acidophilic. ^{ruffles}
E.M.	- few organelles + - features of immature cells i.e. centrioles + free ribosomes.	- Golgi image. - E.M. features of ptn. secreting cells i.e. many mit., rich in r.ER. + well developed G.A. - euchromatic nucleus. - Rich in alkaline Phosphatase enzyme	- E.M. features of active cells but e' less mit., r.ER & smaller GA. - The lacunae are connected by canaliculi through w processes are connected by gap junctions for exchange of nutrients & waste products. - N.B. Osteocytes cannot divide so present singly inside their lacunae. No interstitial growth.	- E.M. has ruffled border = microvilli. - rich in mit., G.A., vesicles + lysosomes. - N.B. Osteoclasts are not phagocytic
Functions	1. Give rise to → Osteoblasts during growth & healing of fractures. 2. In avascular medium ^{they} may give chondroblasts.	1. Bone forming cells. 2. Synthesis of osteoid matrix 3. Deposit Ca in the Matrix by alkaline phosphatase 4. When completely surrounded by calcified matrix → change into Osteocytes.	1. Bone Maintaining Cells 2. maintain organic part of matrix 3. Maintain hardness of matrix by continuous deposition of Ca	1. Bone resorbing cells: a) secrete CO ₂ ^{which change into} carbonic acid → acidic medium → dissolve Ca → decalcification. b) their proteolytic enzs → destroy the organic part of the matrix. 2. Bone remodelling during growth & after fractures.



E.M. features of ptn. secreting cells i.e.

many mit., rich in r.ER. + well developed G.A.
- euchromatic nucleus.

Rich in alkaline Phosphatase enzyme

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N.B. Osteocytes cannot divide so present singly inside their lacunae. No interstitial growth.

Bone destruction.

1. Bone resorbing cells:

a) secrete CO₂ ^{which change into} carbonic acid → acidic medium → dissolve Ca → decalcification.

b) their proteolytic enzs → destroy the organic part of the matrix.

2. Bone remodelling during growth & after fractures.

Compact bone [Ivory bone]

- In shafts of long bones & form outer cover of spongy bone.
- Formed of:

1. Periosteum:

- Vascular c.t. w covers bone: Formed of:
- * Outer fibrous layer = collagenous bundles + fibroblasts + bl.vs.
- * Inner osteogenic (cellular) layer = osteogenic cells w differentiate → Osteoblasts.

Functions: 1. protection of bone.

2. give nutrition to bone.

3. " muscle attachment.

4. growth of bone: osteogenic cells → osteoblasts → Form matrix
(appositional) → osteocytes. deposit + Ca
can not divide

2. Endosteum:

- a single layer of osteogenic cells in a delicate layer of c.t. lining b.m. cavity. Functions: protection & growth of bone.

3. Haversian Systems [Osteons]

= Structural unit of compact bone. = Cylindrical structures parallel to the long axis of bone. Formed of:

(a) Haversian canal: w contains c.t. rich in bl.vs & nerves, surrounded by

(b) Concentric bone lamellae: 5-20 concentric layers of calcified osteoid matrix separated by osteocytes inside lacunae & connected by canaliculi through w they get their nutrition.

4. External Circumferential Lamellae:

bone lamellae = calcified collagenous bundles separated by osteocytes inside lacunae just under the periosteum & parallel to the bony surface.

5. Internal Circumferential Lamellae:

bone lamellae around b.m. cavity & parallel to the endosteum.

6. Interstitial Lamellae:

Irregular bone lamellae + osteocytes inside lacunae in bet. Haversian systems.

* Volkmann's Canals:

transverse or oblique canals w connect Haversian canals e' one another & to Periosteum & b.m. cavity to get better nutrition.

* Perforating fibres of Sharpey:

= Calcified collagenous bundles that arise from tendons or ligaments & perforate the periosteum to be attached to ext. circumferential lamellae. i.e. they are the continuation of tendons to fix tendons & muscles into the bone.

Spongy [Cancellous] Bone

Irregular type of bone 1st formed during fetal life & bone repair.

Structure:

Irregular branching & anastomosing bone trabeculae separated by multiple & irregular bone marrow cavities.

Bone trabeculae = irregular bone lamellae & osteocytes.

No Haversian system or Haversian canals.

The bone surface is covered & periosteum & b.m. cavities lined & Endosteum

Bone Formation [Ossification]

1. Intramembranous Ossification:

In w a membrane of mesenchymal c.t. is changed into spongy bone.
e.g. in flat, short & irregular bones. *mesenchymal c.t. → bone*

1- 1st Ossific centre appear in the centre of the memb. rich in UMCs + bl.vs.

2- UMCs + pericytes differentiate into osteogenic cells → Osteoblasts

Osteoblasts secrete osteoid matrix, deposit Ca in the matrix & change into osteocytes.

3- Many ossific centres are formed in the c.t. memb.

4- The irregular bone trabeculae fuse → Spongy bone.

5- UMCs & bl.vs in the spaces bet. bone trabeculae fuse → B.M. cells

2. Intra-cartilagenous Ossification:

In w a model of cartilage is replaced by mesenchymal c.t. w change into bone e.g. in long bones. *Cartilage → mesenchymal c.t. → bone*

A. 1st Centre of Ossification: [in centre of diaphysis] *shaft*

- ① - chondrocytes **proliferate**, enlarge (**hypertrophy**) & **deposit Ca** in the matrix → become deprived from nutrition & die leaving empty spaces separated by calcified matrix (basophilic).
- ② - perichondrium becomes more vascular so, UMCs → osteogenic cells → osteoblasts → thin collar of bone matrix = Subperiosteal collar
- ③ - Osteoclasts open holes in the collar to allow vascular bud [bl.vs + UMCs] to **invade** the cavities.
- ④ - UMCs → osteogenic cells w attach to remnants of the calcified basophilic matrix & change into osteoblast w form acidophilic matrix → [Spongy bone]
- ⑤ - Osteoclasts resorb central irregular trabeculae → single b.m. cavity & UMCs → b.m. cells / while osteoblasts deposit new bone [Remodelling]

⑥ - Complete Ossification: Osteoblasts form concentric bone lamellae around bl.vs. to form Haversian canals & systems

B. Secondary Centre of Ossification: in Epiphysis
Similar to 1st centre " " but until spongy bone is formed.

So, cartilage is replaced by bone except in 2 regions:
① Articular cartilage: throughout life ② Epiphyseal plate: till age of 21-23

Growing End of Bone = [Epiphyseal plate]:

[Stages of Intracartilagenous Ossification]:

1. Zone of resting cartilage: small scattered chondrocytes.
2. Zone of Proliferation: Chondrocytes $\uparrow$ in N^o & arranged in parallel rows.
3. Zone of Maturation [Hypertrophy]: Chondrocytes $\uparrow$ in size & accumulate glycogen & alk. phosphatase.
4. Zone of Calcification: Chondrocytes deposit Ca^{++} in the matrix under the periosteum, so cells die $\rightarrow$ leaving empty spaces.
5. Stage of Invasion: Vascular bud (bl.vs + UMCs) invade the empty spaces through holes formed by osteoclasts in periosteal collar.
6. Zone of Spongy bone Formation:
UMCs $\rightarrow$ osteogenic cells $\rightarrow$ osteoblasts $\bar{w}$ lay matrix on calcified remnants $\rightarrow$ bone trabeculae $\bar{w}$ fuse $\rightarrow$ spongy bone.
7. Remodelling: Osteoclasts resorb central bone trabeculae $\rightarrow$ central h.m. cavity
8. Zone of Complete Ossification: Osteoblasts start to form concentric bone lamellae around bl.vs. to form Haversian canals & Haversian systems.

N.B. A stable bl. Ca^{++} level is reached by balance bet. osteoblasts & osteoclasts. This is hormonally regulated.

Parathyroid hr. stimulate osteoclasts while
Calcitonin " inhibits " "

So Calcitonin is given as a treatment for cases of osteoporosis.

Nerve Fibre:

Axon. covered by axolemma & contains cytoplasm called axoplasm.
The conical expansion at its origin from the nerve cell = axon Hillock.

Types of nerve fibres:

1. Unmyelinated: (no myelin sheath):

- Unmyelinated out neurolemma [naked] e.g. in grey matter.
- Unmyelinated in neurolemma e.g. in postganglionic sympathetic fibre

2. Myelinated: (have myelin sheath):

- myelinated out neurolemma e.g. in white matter.
- myelinated in neurolemma e.g. in peripheral nerves.

Neurolemma [Schwann Cells]

Flat cells & flat nuclei around the myelin sheath.

Functions:

1. Insulation of nerve impulse.
2. Formation of myelin sheath in peripheral nerves.
3. Regeneration of n. fibres where the axon grows ^{from the proximal stump} along the path formed by Schwann cells.

Myelin Sheath

A lipoprotein sheath, so dissolves during preparation, but stains black w/ osmic H.

It is interrupted at intervals [Nodes of Ranvier] = the spaces bet. adjacent Schwann cells.

The nodes divide m. sheath into segments called internodal segments.

Stages of myelination: in peripheral nerves

1. axon invaginates into Schwann cell & becomes surrounded by a single turn of cell membrane.
2. Schwann cell rotates several times (up to 50) in a spiral form around the axon & the cytoplasm is squeezed → compaction of the turns →
3. fusion of the cell membranes of the turns → myelin sheath.

In PNS

myelination by Schwann cell w wraps around one segment of 1 axon

Functions:

speeds up the nerve impulse.

In CNS

by Oligodendroglia w wraps around one segment of many axons (10-60)

Structure of Neurons:

Cell body [Perikaryon]:

= The part of the neuron containing the nucleus & surrounding cytoplasm.

Size: varies from $4\mu m$ as in granular cells of cerebellum to $100\mu m$ as in AHCs.

Shape: unipolar (globular), bipolar (fusiform), Multipolar stellate.
pyramidal.
pyriform.

Nucleus: large, rounded, euchromatic & prominent nucleolus.

Cytoplasm: contains:

1. **mitochondria:** scattered throughout the cytoplasm.
2. **Golgi apparatus:** around the nucleus, stained e' Ag.
3. **Neurofilaments:** intermediate filaments ($10nm$) in the perikaryon & processes to provide structural support. **Fixatives** gather them into bundles ($2\mu m$) called **neurofibrils** (visible by L.M. & stain brown e' Ag)
4. **Microtubules:** ($25nm$) arranged in bundles in the perikaryon & processes for transport of neurotransmitter along the axon.
5. **Centrioles** are **absent**, so neurons cannot divide.
6. **Nissl bodies:** basophilic granules = segments of rER & numerous **polyribosomes** to form both structural proteins & protein for transport abundant in large nerve cells as in motor neurons. present in **nerve cell & dendrites**, **absent** in **axon & axon hillock**.
7. **Inclusions:**
 - a. **lipofuscin** (golden brown) - undigested material in lysosomes, $\uparrow\uparrow$ e' age.
 - b. **melanin** (brown or black) in **Substantia nigra** of midbrain.
 - c. **fat droplets** (energy reserve).

Processes:

Dendrites

- Multiple, short & thick.
- Branch like a tree (branches arise at acute angle).
- become thinner towards its end.
- Have Nissl granules.
- Covered e' processes (dendritic spines) for synaptic contact.
- Carry nerve impulses towards the n. cell

Axon

- Single, long, thin.
- Do not branch except at its end.
- may give collateral (at right angle)
- Have uniform diameter.
- No Nissl granules
- No spines.
- carry impulses away from n. cell

Both have mitochondria, neurofibrils & neurotubules.

(7) points

Muscles

Striated: skeletal & cardiac
Non-striated: Smooth - plain

1. Skeletal

- Site** - attached to skeleton, face & tongue.
pharynx, upper 1/3 of oesophagus.
Diaphragm, cremasteric muscle.
- Action** - Voluntary except pharynx & upper 1/3 of oes.
- supplied by motor nerve.
- Origin** - mesodermal [fusion of myoblasts → myocytes]
- Regeneration** - limited from satellites outside the sarcolemma
- I.M.** length variable
size - diameter 10 - 100 μm
- Shape** Cylindrical & non-branching except in face & tongue
- Sarcolemma** - Very thick, covered e' basal lamina then endomysium
- Sarcomeres** - acidophilic
- Striations** - Clear due to regular myofibrils
euchromatic
- Nuclei** - Multiple, Oval & peripheral.

EM

- Organelles** - Myofibrils: numerous, parallel
- mitochondria: numerous, in rows bet. myofibrils (sarcosomes)
 - Sarcoplasmic reticulum = modified SER around myofibril
Site for Ca²⁺ storage & pump.
 - Triad** - of Tubular system
 - few ribosomes, small Golgi around nuclei (in perinuclear cytoplasm)

Inclusions - Myoglobin, glycogen grs., fat droplets bet myofibrils (give energy)

Myoglobin: O₂-binding pigmented ptn, provide O₂ for oxidative reaction.

Intercalated disc

Type red, white, intermediate in diff. proportions

Organization of muscle fibres:

- parallel muscle fibres are grouped into bundles covered e' c.t.
1. Epimysium: dense c.t. that covers the whole muscle.
 2. Perimysium: less dense c.t. - descend from epimysium & surrounds each bundle.
 3. Endomysium: reticular fb around the fibres. Connected to basal lamina.
- All carry b.l.v.s. & nerve fibres to nourish the muscle fibres by diffusion

2. Cardiac

- Wall of heart (myocardium)
- Involuntary
- autonomic: control strength & rate of contract
- mesodermal
- Cannot regenerate, heal by fibrosis e.g. myocardial infarction.
- 80 μm
about 15 μm.
- Cylindrical, branch & anastomose running in different directions
connected by vascular endomysium.
- thin
- acidophilic
- Irregular striations + intercalated disc
- each fibre is formed of cells - myocytes
each e' single, central & oval N.
- Fewer
- more numerous, larger & more cristae.
- One terminal tubule accounts for T-tubule
→ **Diad** of tubular system (At level of Z-line)
- other organelles: few

- Myoglobin, glycogen, fat, lipofuscin pig = waste product of ageing → brown atrophy of heart.
- Atrial granules: contain diuretic hormones → regulate Na⁺ & H₂O balance
- Atrial muscles have endocrine function

Intercalated disc

Type red

3. Smooth

- Wall of bl. vessels
- Wall of viscera (respiratory, digestive, urinary) & genital systems
- skin & eye. (Arrector pili muscle in skin)
- Involuntary
- autonomic
- Mesodermal [UMC]. On need, can undergo hypertrophy (↑ size) & hyperplasia (↑ N°) e.g. in hypertension preg. uterus
- can regenerate by mitosis or from pericytes
- 20 μm in small vessels → 500 μm in pregnant uterus
- 8 μm
- Spindle shaped. In L.S. the tapering end is adjacent to the broad part of the adj. cell. In T.S. some are large & nucleus & some are small & no nucleus.
- thin, covered e' basal lamina.
- Acidophilic
- No striations as myofibrils are few & overlapping
- Single, central & oval (cigar-shaped) → Cork-screw appearance during contraction.
- Sarcolemma: have invaginations (caveola) but No T-tubules so, **No triad**
the fibres are joined by gap junction.
- **Myofibrils**: few overlapping: 3 types:
thin (actin), thick (myosin) + intermediate (desmin) + vimentin
- Actin insert into attachment plaques on inner side of sarcolemma & interact e' myosin & interact e' other actin filaments & insert into intracytoplasmic dense bodies (correspond to Z-line in striated ms)
- desmin filaments also insert into dense bodies
- Mit., SER, ribosomes, G.A. at perinuclear area.

- Myoglobin & glycogen

Intercalated disc

Type white

Organization of Smooth muscles:

connected by gap junction, surrounded by endomysium arranged in bundles surrounded by perimysium rich in b.l.v.s.

Functions of smooth muscles:

Slow, sustained involuntary contraction modulated by autonomic innervation & hormones.

E.M. of Myofibrils :

SQ

- 3 -

- Each myofibril shows alternating dark & light bands.
- The dark bands of adjacent myofibrils are present at the same level giving the appearance of t.v. striations.
- The light bands are called I. bands [isotropic] (does not alter plane of polarized light).
- The dark " " " A. bands [Anisotropic] (alters the " " " light $\rightarrow$ 2 planes).
- The dark band has pale area in its centre called H-zone bisected by M-line.
- The light " " dark line " " " Z-line.

Sarcomere = the segment bet. 2 adjacent Z lines = 2.5 μ m in length.

- It is the functional unit of contraction.

- Contains 2 types of myofilaments:

→ thick myosin = [5 nm] restricted to the A band.

→ thin actin [6 nm]: extends from Z line, pass in the I-band till beginning of H-zone. **M-line** = fine connections bet. adjacent myosin filaments.

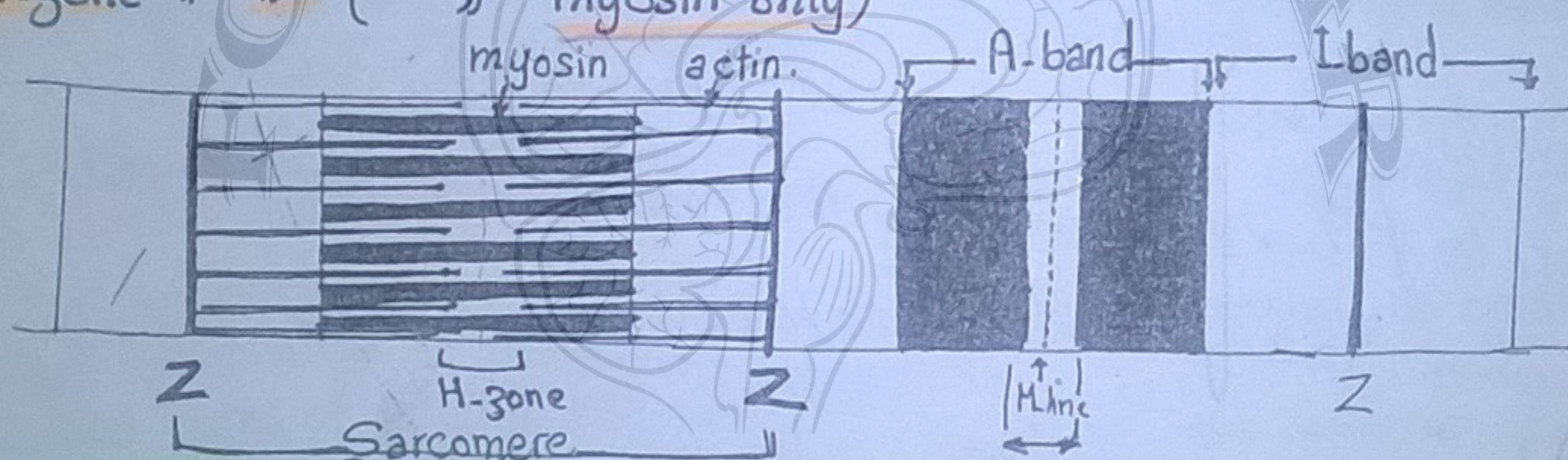
- During Contraction: actin glides over myosin $\rightarrow$ shortening of sarcomere. $\rightarrow$ disappearance of H-zone.

Only I-band is shortened while A band remains constant.

- A band is dark (contains both actin & myosin)

- I " " pale (" actin only)

- H-zone " " (" myosin only)



Triad of Tubular System : It includes: H-zone

a) **T-tubule** : formed by invagination of sarcolemma into the sarcoplasm.

- Its cavity is continuous w/ the extracellular space.

- It extends transversely into the sarcoplasm like a collar at the level bet. A & I bands.

b) **2 Sarcoplasmic tubules** :

- modified parts of sarcoplasmic reticulum & continuous w/ it. It forms t.v. terminal cisternae. Each 2 ~ tubules surround one t.v. T-tubule forming Triad

The Role of Tubular System in muscle contraction: Function of st.

As the nerve impulse reaches the motor end plate, the sarcolemma is depolarized. Depolarization spreads along the T-tubule to sarcoplasmic reticulum w/ pump Ca^{++} $\rightarrow$ gliding of actin over myosin till the middle of the A-band

During Contraction:

• I band become shorter, H-zone disappears while A-band remains constant.

• Sarcomeres & muscle fibres become shorter

• the length of actin & myosin filaments do not change

After depolarization stops: Ca^{++} is actively transported to the SER $\rightarrow$ muscle relaxation decreasing Ca^{++} in Sarcoplasm.

The classification of fiber types in muscle biopsies has clinical

Types of skeletal muscle fibres: Significant for diagnosis of certain diseases (4)
Formed of 3 types of fibres in diff. proportions: red, white & intermediate

(12) SQ I Red	II White Such as diseases due to mitochondrial disorders.
• red color due to: 1, 2, 3 pathway 1. rich in myoglobin (aerobic) ^{product of} 2. More numerous & larger mitoch. 3. rich vascularity • smaller diameter • less glycogen • more sarcoplasm • fewer myofibrils • Irregular striations • F. slow sustained (prolonged) contractions without fatigue • Examples: - athletic ms. (marathon runners) - long muscles of back [in humans] (erect posture) - Chest ms of birds.	- white due to: 1. poor (anaerobic by glycolysis) 2. less 3. poor - larger - more glycogen - less - full of myofibrils - regular striations. ^{due to rapid generation of ATP.} - Fast, short contractions & easy fatigue. - muscles of eye & digit - short distance sprinter ms.

III - Intermediate fibres e' intermediate characters bet. red & white fib.

Musculotendinous Junction: SQ

Muscle fibres stop abruptly. The sarcolemma & endomysium continue e' the c.t. fibres of perimysium & epimysium.

At junction of the muscle with the tendon. The muscle fibers taper off and the c.t. components of the muscle continue with tendons. Collagen fibers of the tendon insert among muscle fibers.

General Characteristics of muscular tissue:

1. Mesodermal.
2. the structural & functional unit = Muscle fibre.
3. the cell memb. of muscle fibre = Sarcolemma.
4. " cytoplasm " " = Sarcoplasm.
5. Sarcoplasm: acidophilic & contains:
 - all organelles: (mit., sER & myofibrils) & inclusions (myoglobin, fat & glycogen).
6. s-ER is called sarcoplasmic reticulum.
7. Muscle fibres may be → striated (skeletal & cardiac).
or → non-striated (smooth ms).

Intercalated discs:

def.: the cell memb. of adjacent cardiac myocytes that form the cardiac ms. fs.

L.M.: dense lines at intervals along the length of the cardiac ms. fibres.

E.M. Have the shape of stairway e' 2 regions (t.v. & lat.) & 3 types of Junction

1. t.v. component: at right angle to the fibre [riser of stairway] contains Desmosomes & adherens J. (fascia adherens): prevent their separation during contraction.
 ↳ Anchors Actin Filaments.
2. Lat. component: parallel to the fibre [step of stairway]: have gap J: allows impulses to pass from one cell to the other. Their site protects them from contraction forces.

Function of Cardiac muscle:

Involuntary, spontaneous rhythmic contraction controlled by not initiated by autonomic innervation & hormones.

The wall of heart: 2 atria & 2 ventricles. Formed of 3 layers:

1. Epocardium = visceral layer of pericardium.
2. Myocardium = cardiac muscle fibres: thicker in ventricles than in atria.
3. endocardium = the lining endothelium from inside.

Valves of Heart:

= Folds of endocardium = middle layer of dense fibrous c.t. rich in collagenous & elastic fibres + macrophages covered e' s squamous endothelium

Purkinje Muscle fibres

- modified Cardiac ms. fs. present in the A.V bundle & its branches.
- Conduct impulses faster than cardiac ms. fs. grouped into bundles surrounded by c.t. sheath.

Histological characters of Purkinje fibres:

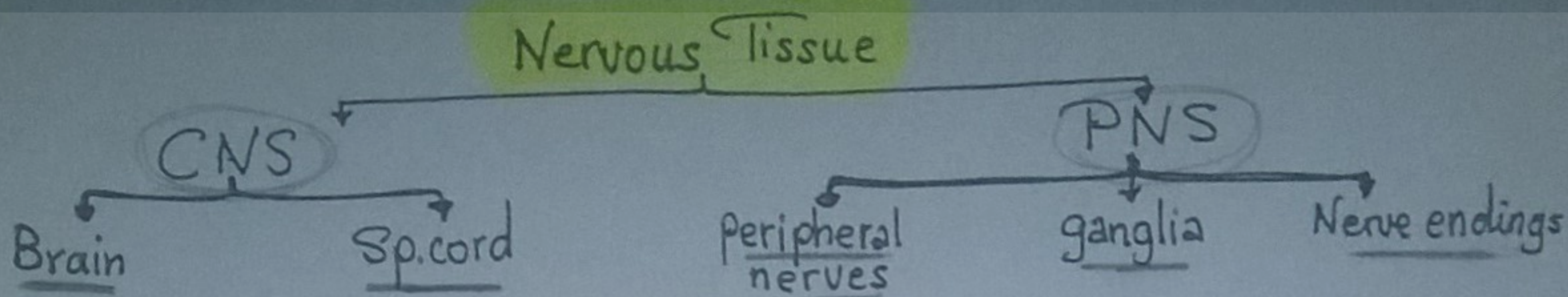
1. larger in diameter than cardiac muscle.
2. Have paler sarcoplasm as it is rich in *glycogen (dissolves during preparation) so appears vacuolated. ↳ mitochondria.
3. have few myofibrils w are peripherally situated.
4. No striations.
5. No intercalated discs.
6. have one or 2 eccentric nuclei.

Differences bet. the 3 types of muscles.

	Skeletal	Cardiac	Smooth
1 Site	- Attached to skeleton	- Wall of heart	- Wall of Viscera.
2 Size	- Largest (up to 100 μ m)	- Med. sized (20 μ m)	- smallest (8 μ m)
3 Shape	- Cylindrical &	- Cylindrical &	- spindle-shaped.
4 branching	- non-branching	- branched	- non-branching.
5 Sarcolemma	- Thick	- V. thin	- thin.
6 Striations	- Striated	- Non-clear striations	- Non-striated.
7 Sarcomere	- regular	- " sarcomeres	- absent.
8 Tubular system	- Triad	- Diad	- absent.
9 type	- Red & white	- red	- white.
10 Nuclei	- Multiple, peripheral	- Single, central	- Single, central.
11 Cell Junctions	- absent	- 3 at intercalated discs	- absent.
12 Intercalated disc	- absent	- F. adhers Desmosomes gap j.	- gap j.
13 Action	- Voluntary	- Involuntary	- Involuntary
14 innervation	- (motor)	- (autonomic)	- (autonomic)
15 Origin	- myoblast	- myoblast.	- UMC
16 Regen.	- from satellites	- cannot regenerate	- mitosis or from pericy
17 Modification	- Muscle spindle	- Purkinje fibres	-
18 Single fibre =	- Single cell	- many cells	- single cell

* Similarities

- myofibrils
- Mitochondria
- Acidophilic cytoplasm
- Inclusions
 - has myoglobin
 - glycogen
- epimysium
- Peri
- endo



Neurons

The structural unit of nervous tissues. formed of:
Cell body [perikaryon] & its processes [axon & dendrites].

Classification of neurons: SQ

A. According to No. of processes: [polarity]:

- (1) **Unipolar**: Have a single process that divides into 2 branches (T-shaped) one extends to a peripheral endings & acts as a dendrite but structurally it is similar to axon. & the other towards CNS & act as an axon. The impulse travels from the dendrite to the axon directly without passing through the perikaryon e.g. in spinal ganglia & mesencephalic nucleus of trigeminal nerve.
- (2) **Bipolar**: have one dendrite & one axon e.g. in retina of eye, olfactory mucosa, cochlear & vestibular ganglia of ear.
- (3) **Multipolar**: have one axon & many dendrites: 3 types:
 - Stellate: e.g. AHCs in sp. cord & sympathetic nerve cells.
 - Pyramidal: e.g. Δ cells in cerebral cortex.
 - Pyriiform: e.g. Purkinje cells in cerebellar cortex.

B. According to function:

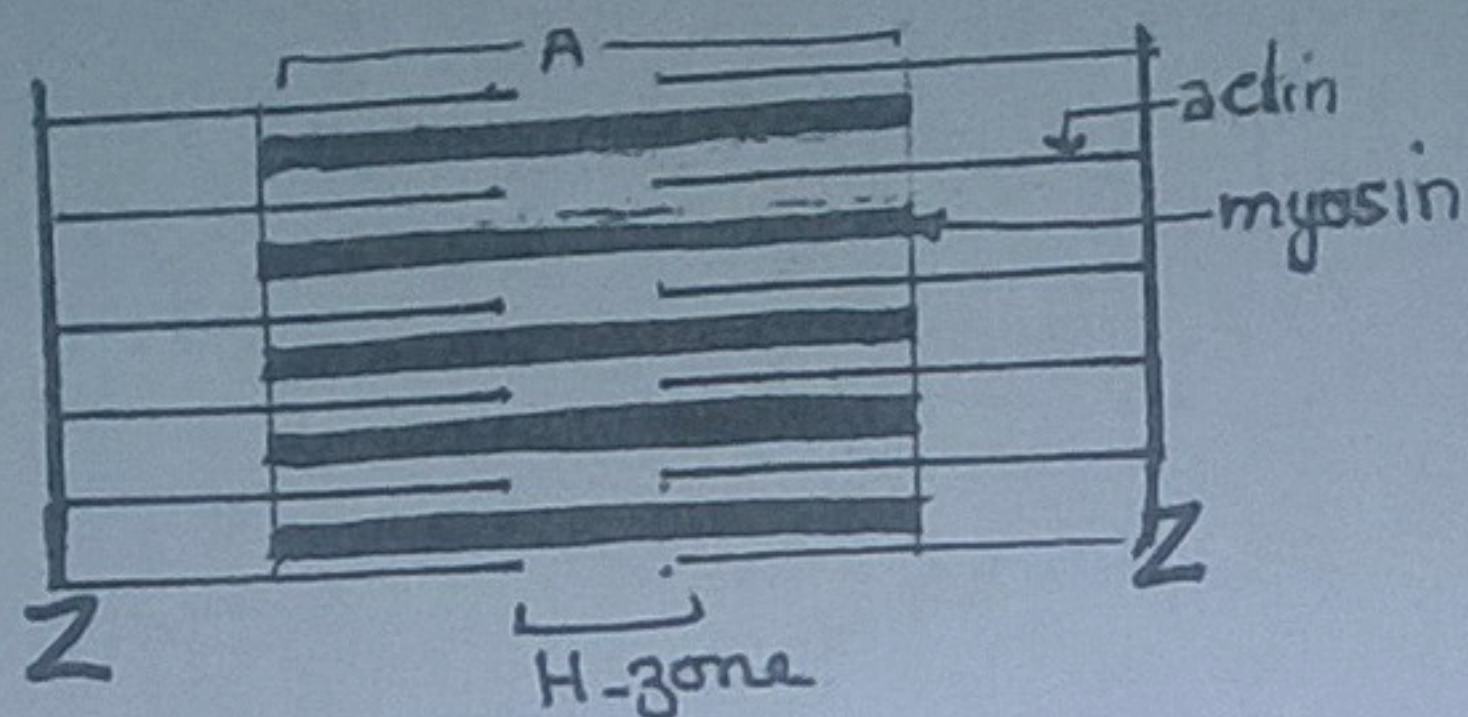
- (1) **Sensory neurons**: receive sensory stimuli e.g. post. root ganglia.
- (2) **Motor neurons**: control effectors as muscles & glands e.g. AHCs.
- (3) **Interneurons**: connect neurons as in retina & sp. cord.
 ↳ Complete reflex arch → (conducting function)

C. According to length of axon:

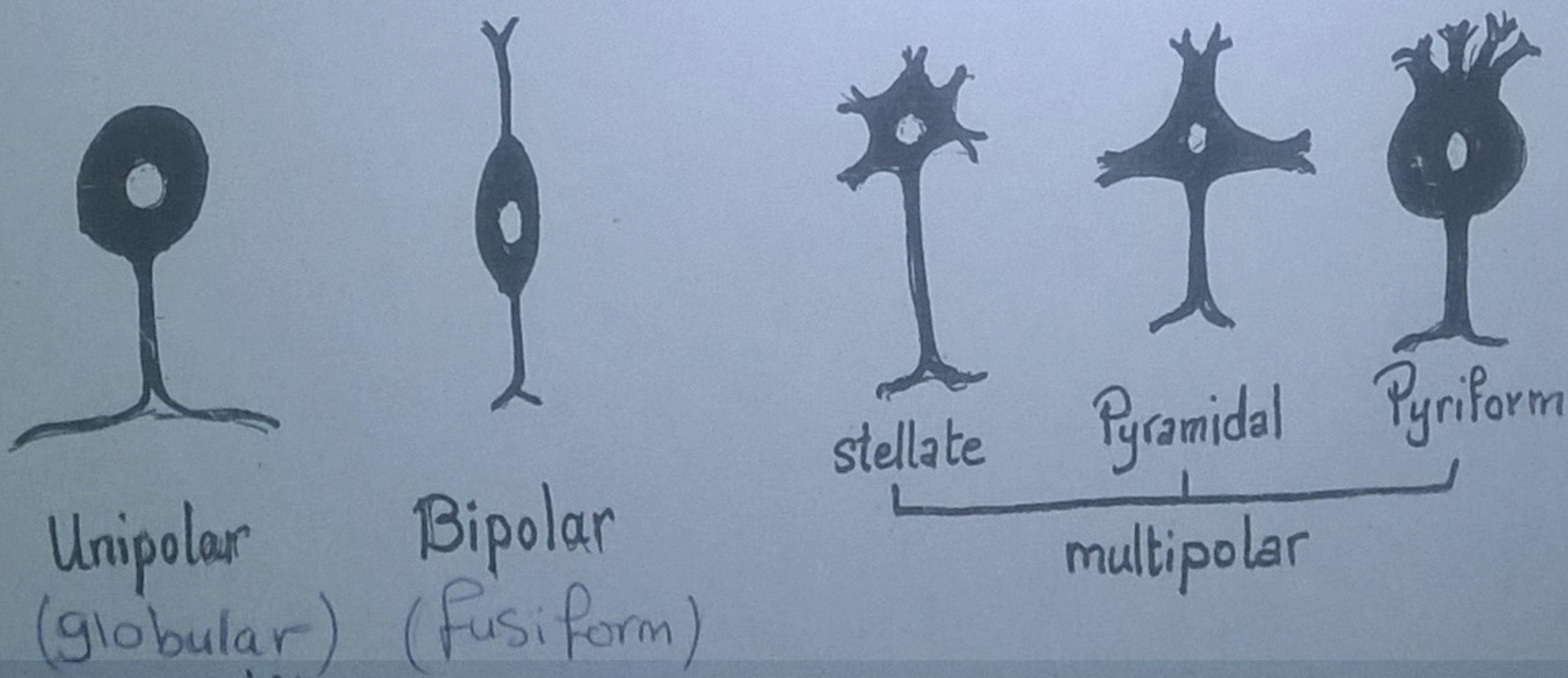
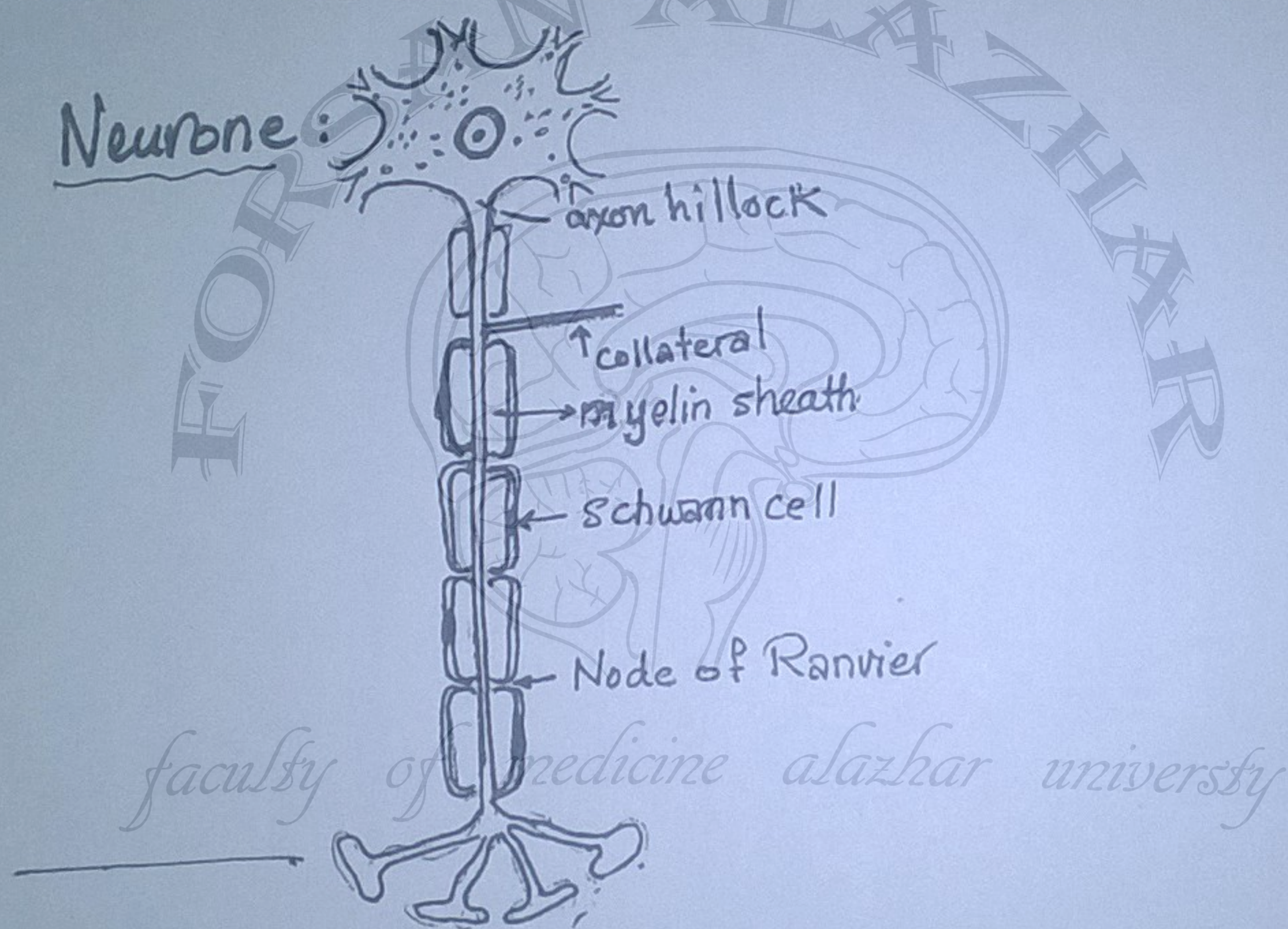
- (1) **Golgi type 1**: have long axon that leaves the grey matter & enters the white matter e.g. motor neurons in the sp. cord, Δ cells in cerebral cortex, Purkinje cells in the cerebellar cortex.
- (2) **Golgi type 2**: have short axon that does not leave the grey matter & never enters the white matter e.g. interneurons in cerebral & cerebellar cortex.

Skeletal muscle

Sarcomere



Neurone:



Structure of Neurons:

Cell body [Perikaryon]:

= The part of the neuron containing the nucleus & surrounding cytoplasm.

Size: varies from $4\mu m$ as in granular cells of cerebellum to $100\mu m$ as in AHCs.

Shape: unipolar (globular), bipolar (fusiform), Multipolar stellate.
pyramidal.
pyriform.

Nucleus: large, rounded, euchromatic & prominent nucleolus.

Cytoplasm: contains:

1. **mitochondria:** scattered throughout the cytoplasm.
2. **Golgi apparatus:** around the nucleus, stained e' Ag.
3. **Neurofilaments:** intermediate filaments ($10nm$) in the perikaryon & processes to provide structural support. **Fixatives** gather them into bundles ($2\mu m$) called **neurofibrils** (visible by L.M. & stain brown e' Ag)
4. **Microtubules:** ($25nm$) arranged in bundles in the perikaryon & processes for transport of neurotransmitter along the axon.
5. **Centrioles** are **absent**, so neurons cannot divide.
6. **Nissl bodies:** basophilic granules = segments of rER & numerous **polyribosomes** to form both structural proteins & protein for transport abundant in large nerve cells as in motor neurons. present in nerve cell & dendrites, **absent** in axon & axon hillock.
7. **Inclusions:**
 - a. **lipofuscin** (golden brown) - undigested material in lysosomes, $\uparrow\uparrow$ e' age.
 - b. **melanin** (brown or black) in **Substantia nigra** of midbrain.
 - c. **fat droplets** (energy reserve).

Processes:

Dendrites

- Multiple, short & thick.
- Branch like a tree (branches arise at acute angle).
- become thinner towards its end.
- Have Nissl granules.
- Covered e' processes (dendritic spines) for synaptic contact.
- Carry nerve impulses towards the n. cell

Axon

- Single, long, thin.
- Do not branch except at its end.
- may give collateral (at right angle)
- Have uniform diameter.
- No Nissl granules
- No spines.
- carry impulses away from n. cell

Both have mitochondria, neurofibrils & neurotubules.

(7) points

Nerve Fibre:

Axon. covered by axolemma & contains cytoplasm called axoplasm.
The conical expansion at its origin from the nerve cell = axon Hillock.

Types of nerve fibres:

1. Unmyelinated: (no myelin sheath):

- Unmyelinated out neurolemma [naked] e.g. in grey matter.
- Unmyelinated e neurolemma e.g. in postganglionic sympathetic fibre

2. Myelinated: (have myelin sheath):

- myelinated out neurolemma e.g. in white matter.
- myelinated e neurolemma e.g. in peripheral nerves.

Neurolemma [Schwann Cells]

Flat cells & flat nuclei around the myelin sheath.

Functions:

- Insulation of nerve impulse.
- Formation of myelin sheath in peripheral nerves.
- Regeneration of n. fibres where the axon grows ^{from the proximal stump} along the path formed by Schwann cells.

Myelin Sheath

A lipoprotein sheath, so dissolves during preparation, but stains black e osmic H.

It is interrupted at intervals [Nodes of Ranvier] = the spaces bet. adjacent Schwann cells.

The nodes divide m. sheath into segments called internodal segments.

Stages of myelination: in peripheral nerves

- axon invaginates into Schwann cell & becomes surrounded by a single turn of cell membrane.
- Schwann cell rotates several times (up to 50) in a spiral form around the axon & the cytoplasm is squeezed → compaction of the turns →
- fusion of the cell membranes of the turns → myelin sheath.

In PNS

myelination by Schwann cell w wraps around one segment of ^{single} axon

Functions:

speeds up the nerve impulse.

In CNS

by Oligodendroglia w wraps around one segment of many axons (10-60)

Nerve Trunk

The Nerve is covered e' dense c.t. = **Epineureum**.

Nerve fibres are arranged in **bundles** surrounded by **Perineureum**.

Peri = Flat epith. like cells joined by tight junction = Barrier to protect n. fibres.

Nerve fibres are connected by **Endoneureum** [Sheath of **Henle**] = reticular fibres formed by neurolemma.

In Hx & E sections, myelin dissolves. Can be stained e' **Osmic A** → black rings.

Ganglia

def. : Collection of nerve cells outside the CNS.

2 types

→ Spinal (sensory)

→ autonomic (sympathetic & parasympathetic).

Spinal ganglion	Sympathetic
1. Covered e' thick c.t. capsule	1 - thin c.t. capsule
2. Cells → unipolar with central N. → Variable in size → larger cells → arranged in groups or rows	2 - multipolar stellate. with eccentric N. → uniform in size. → smaller. → scattered.
3. Cells are surrounded by large No. of satellite cells.	3 - few satellites.
4. Glomerulus = coiling of the axon at its beginning from the nerve cell (present)	4 → No glomerulus. <i>glomeruli</i> <i>مجموعات</i> <i>loop cells</i> <i>حلقات</i>
5. Nerve fibres : myelinated	5 - Non-myelinated n. fibres.
6. Less bl. vessels.	6 - more bl. vs.
7. No synapse bet. cells.	7 - present.

Synapse

def.: the site of contact bet. neurons or bet. neuron & effector.

Histological Structure:

1. Presynaptic side:

rich in mit. + synaptic vesicles (contain chemical transmitter) in chemical synapse. many are associated & separate zones of dense cytoplasm

2. Synaptic cleft: 20-30 nm: shows delicate fibres or granules.

3. Postsynaptic side:

Has receptors for the chemical transmitter. Have continuous zone of dense cytoplasm associated & network of filaments = synaptic web.

Classification:

A. According to way of transmission of n. impulse:

(1) Chemical: (most common) in an electric impulse from presynaptic memb. is converted into chemical signal to act on postsynaptic side.

(2) Electrical: in an ionic signal pass through gap junction bet. pre & post synaptic membranes.

B. According to site of contact of the axon:

(1) Axosomatic: axon synapse & cell body.

(2) Axodendritic: " " " " dendrite

(3) Axoaxonic: " " " " axon

C. According to relative thickness of cytoplasmic densities on pre & post synaptic membranes:

(1) Asymmetric

- the postsynaptic density is thicker
- the synaptic cleft is about 30 nm

(2) Symmetric

- the pre & post synaptic densities are similar
- synaptic cleft: about 20 nm

Degeneration & Regeneration of Nerves

On nerve injury, there are 2 types of changes:

1. Retrograde degeneration:

Changes in the nerve cell & proximal part of nerve fibre.

1. The nerve cell [Perikaryon]: swell, loses dendrites & become globular
2. The nucleus: becomes eccentric
3. Chromatolysis: Nissl bodies disappear → less basophilia.
4. Mitochondria & G.A.: disappear.
5. Neurofibrils: fragment & disappear
6. Lysosomes: ↑↑

2. Wallerian degeneration:

Changes in the distal part of the nerve fibre:

- The axon: (neurofibrils) become beaded, segmented & finally disappear
- Myelin sheath: the internodal segments [fermentation chambers] as fat splits into F.As. & ^{retract} Widening of Nodes of Ranvier.
- Schwann Cells: proliferate ^{giving rise to} Column of cells to guide axons during regeneration.

(N.B.) Trans neuronal degeneration: changes in axon after injury extend to other neurons e.g. the injured neuron synapses, e.g. visual pathway

Stains for site of degeneration:

1. Ag.: for changes in G.A. & neurofibrils.
2. Basic stain: changes in Nissl grs.
3. Osmic A.: " " " myelin sheath. (degenerated myelin) → F.As.
4. Weigert-Pal stain: for normal myelin sheath.
5. Marchi stain: Potassium dichromate is used to oxidize the normal myelin then osmic A is used to stain the degenerated myelin & not oxidized tracts.

Regeneration:

- Macrophages: remove debris & secrete interleukin I w stimulates Schwann cells to secrete substances that promote nerve growth.
- Axons grow in direction of the columns of Schwann cells. (in proximal part)
- Regeneration is efficient when there is no infection, intact neurolemma & when n. fibres & schwann cell columns are directed to the correct place

SQ

Neuroglia

def: They are the supportive, nutritive & protective tissue bet. neurons.
 (10 times more than neurons). types:

1. Macroglia: [astrocytes]:

- large **star** shaped cells e' **many** processes.
- **ectodermal** in origin. - Have **centrioles**.
- Have large **pale nucleus** (10 nm)
- **E.M.** have bundles of intermediate filaments to **keep their shape**

2 types:	Protoplasmic Astrocytes	Fibrous astrocytes
	- In grey matter - many short & thick processes - cytoplasm rich in granules	- In white matter. - fewer thin & long processes. - less granular & more fibrillary

Functions: 1. Structural support.

2. Their processes end by **expanded end feet** on bl. vessels to get nutrition
3. **Blood brain barrier.**
4. **Repair** by forming **scar tissue.**

2. Microglia [Mesoglia] = [Brain Macrophages]

- Small **spindle**-shaped cells e' **many** processes.
- The cell & processes are **decorated by spines**
- **Mesodermal** in origin - **No centrioles.**
- Have **oval dark nucleus & little cytoplasm.**
- **Phagocytic** cells - In **grey & white** matter.
- Stained e' **vital stain** e.g. **trypan blue.**

3. Oligodendrocytes:

- Small **branched** cell e' **few** processes.
- **Ectodermal** in origin - Have **centrioles.**
- Have **small dark nucleus & cytoplasm rich in mit., G.A, ER, ribosomes.**
- Present in both **grey & white** matter

2 types:	Satellite Oligodendrocytes	Interfascicular Oligodendrocytes
site:	In grey matter	In white matter
	around nerve cells of neurons	In bet. bundles of axons.
Function:	support nerve cells	Form myelin sheath to insulate n. impulses.

4] Ependymal Cells:

- Simple cuboidal or columnar ciliated epith. - Ectodermal in origin.
- lining the central canal of sp. cord & brain ventricles.
- Cilia propel the CSF.

5] Schwann cells:

- Around peripheral nerves.
- Ectodermal in origin.
- Functions
 - insulation of nerve impulses
 - formation of myelin sheath.
 - regeneration of nerves

6] Satellite Cells:

- Cubical cells around nerve cells of ganglia. F. supportive.

Functions of Neuroglia:

Cell type	Function
1. Astrocytes	1. metabolic exchange (nutrition). 2. support. 3. bl. brain barrier. 4. Repair.
2. Microglia	phagocytosis.
3. Oligodendrocytes	Insulation & myelin production (in CNS)
4. Ependymal cells	support
5. Schwann cells	lining cavities of CNS → CSF.
6. Satellite cells	Insulation, myelin production & regeneration (in PNS) support nerve cells in ganglia.

Nerve Endings

A. Receptors

receive stimuli int or ext. & send impulses

Classified into:

- **Exteroceptors**: receive ext. stimuli
- **Proprioceptors**: " stimuli from ms.
- **Interoceptors**: " int. stimuli.

Nerve endings in Epithelium

A Receptors [Exteroceptors]:

① Free nerve endings:

- naked nerve fibres penetrate the b.m. & enter bet epith. cells.

- **Site**: in epidermis of skin & cornea.

- **Function**: receptor for pain (nociceptor), temp. (thermoreceptor), touch, pressure & itching.

② Merkel's disc:

- naked n. fs end in disc like expansion under Merkel cells bet. basal cells of epidermis

- **Site**: epidermis of thick skin (palms & soles).

- **Function**: mechanoreceptor (touch & press).

③ Peritrichial n. endings:

- naked nerve fs around hair follicles

- **Function**: mechanoreceptor (touch & hair movement)

④ Neuroepithelial Ending:

• taste buds in tongue (taste)

• Organ of Corti in ear (hearing)

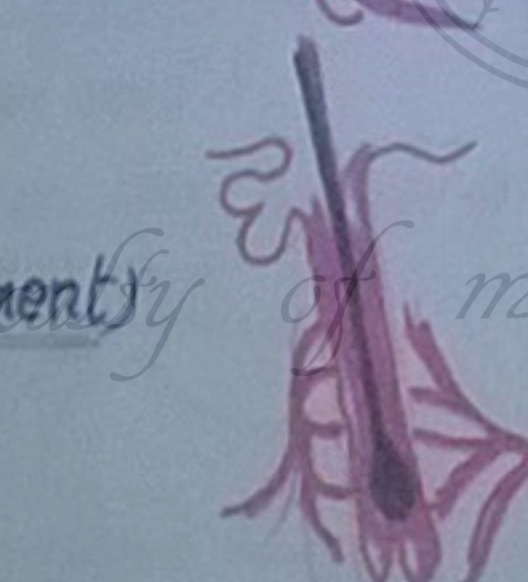
• Crista ampularis, macula utriculi, macula sacculi in ear (equilibrium)

B Effectors:

unmyelinated n. fs form a network around acini of glands as salivary & lacrimal gls. then, branches penetrate the b.m. & end bet the bases of the cells. (F) autonomic regulation of secretion.

B. Effectors

conduct impulses to effector [muscles or glands].



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Nerve endings in C.T.

All are receptors

1. Free n. endings:

- similar to those in epith. - **Site**: dermis of skin & stroma of cornea.

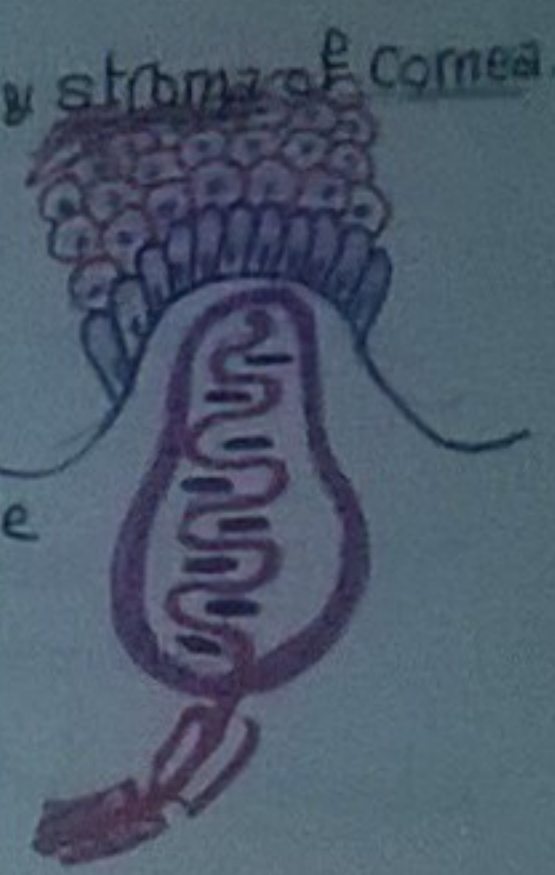
2. Meissner's Corpuscles:

- pear shaped. - covered e' c.t. capsule.

- the axon loses the myelin sheath & neurolemma & spirals up bet. cell layer to end at the upper pole

- **Site**: dermal papillae of skin esp. tips of fingers

- **Function**: mechanoreceptor (touch)



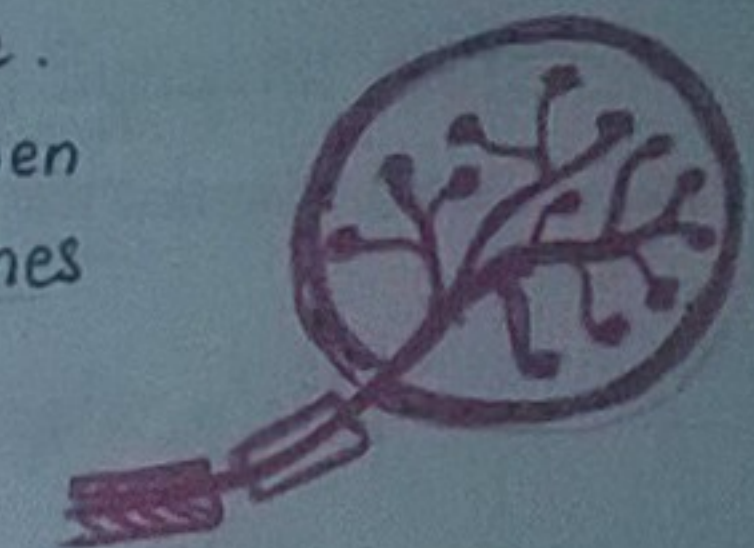
3. Krause's end bulb:

- spherical shaped - covered e' c.t. capsule.

- the axon loses the myelin & neurolemma then penetrate the capsule & give many branches

- **Site**: deep in dermis of skin.

- **Function**: mechanoreceptor (touch)



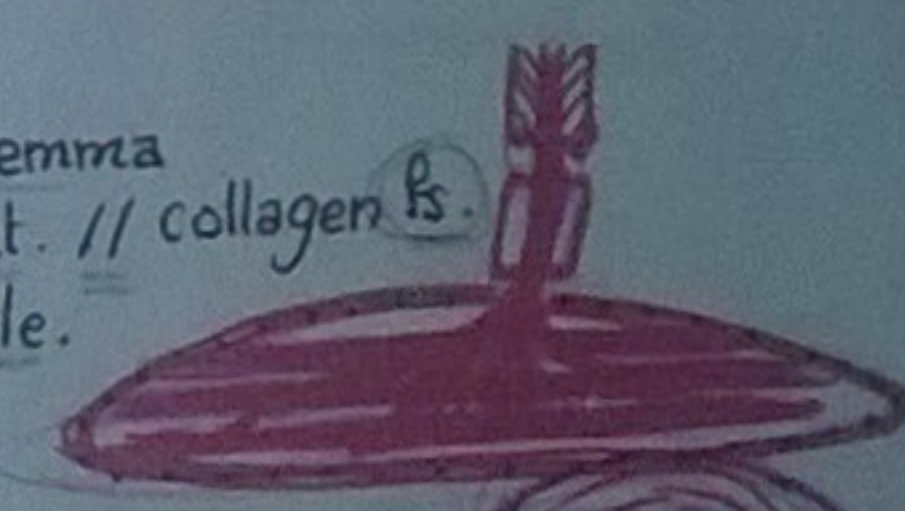
4. Ruffini Organ:

- fusiform. - covered e' c.t. capsule.

- the axon loses the myelin sheath & neurolemma then penetrate the capsule & branches bet. // collagen fs.

- **Site**: deep in dermis of skin esp. sole.

- **Function**: mechanoreceptor (touch).



5. Paccinian Corpuscle:

- Oval (1mm long). - covered e' c.t. capsule

- encloses 20-60 concentric lamellae of flat cells (modified schwann cells) closely packed towards the centre e' gel like material bet. them.

- the neurolemma of the axon becomes continuous e' the capsule. It loses the myelin sheath inside the corpuscle

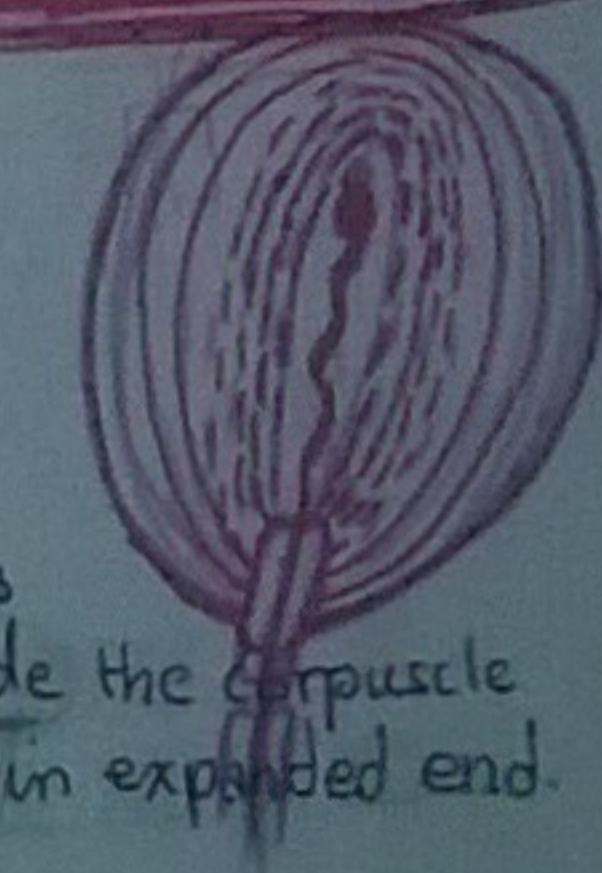
- the naked nerve runs along the long axis & ends in expanded end.

- **Sites**: - dermis & hypodermis of skin.

- periosteum of bone.

- c.t. of some organs e.g. pancreas.

Functions: **Proprioceptor**: mechanoreceptor for pressure, vibration & tension



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6] Tendon Spindle (Golgi tendon Organ):

- spindle shaped
- covered e' c.t. capsule
- the naked nerve fs penetrate the capsule to end around collagen bundles continuous e' those of tendon

Site: tendon near the muscle insertion.

- Function: proprioceptor: conduct data (difference in tension among tendons) to CNS to coordinate muscle contract

Nerve Endings in Muscular tissue

Receptors: proprioceptors:

Muscle Spindle:

- fusiform in shape (6mm long & 1mm in diameter)
- Covered e' thin c.t. capsule.
- the subcapsular space contains tissue fluid, intrafusal ms fibres & n. fibers.
- the intrafusal muscle fs are smaller than skeletal ms e' central non striated part containing nuclei: there are 2 types:
 - a. nuclear bag type: have central dilated nuclear area
 - b. " " chain " : not dilated & have a chain of central nuclei

Innervation:

Afferent Innervation:

Annulospiral ending: large unmyelinated n. fs w end spirally around the non-striated central parts of the intrafusal ms fs.

Flower spray ending: small unmyelinated n. fs w end on the peripheral striated parts of the intrafusal ms fs.

Efferent Innervation:

gamma motor n. fs: innervate the striated part of the intrafusal ms fs.

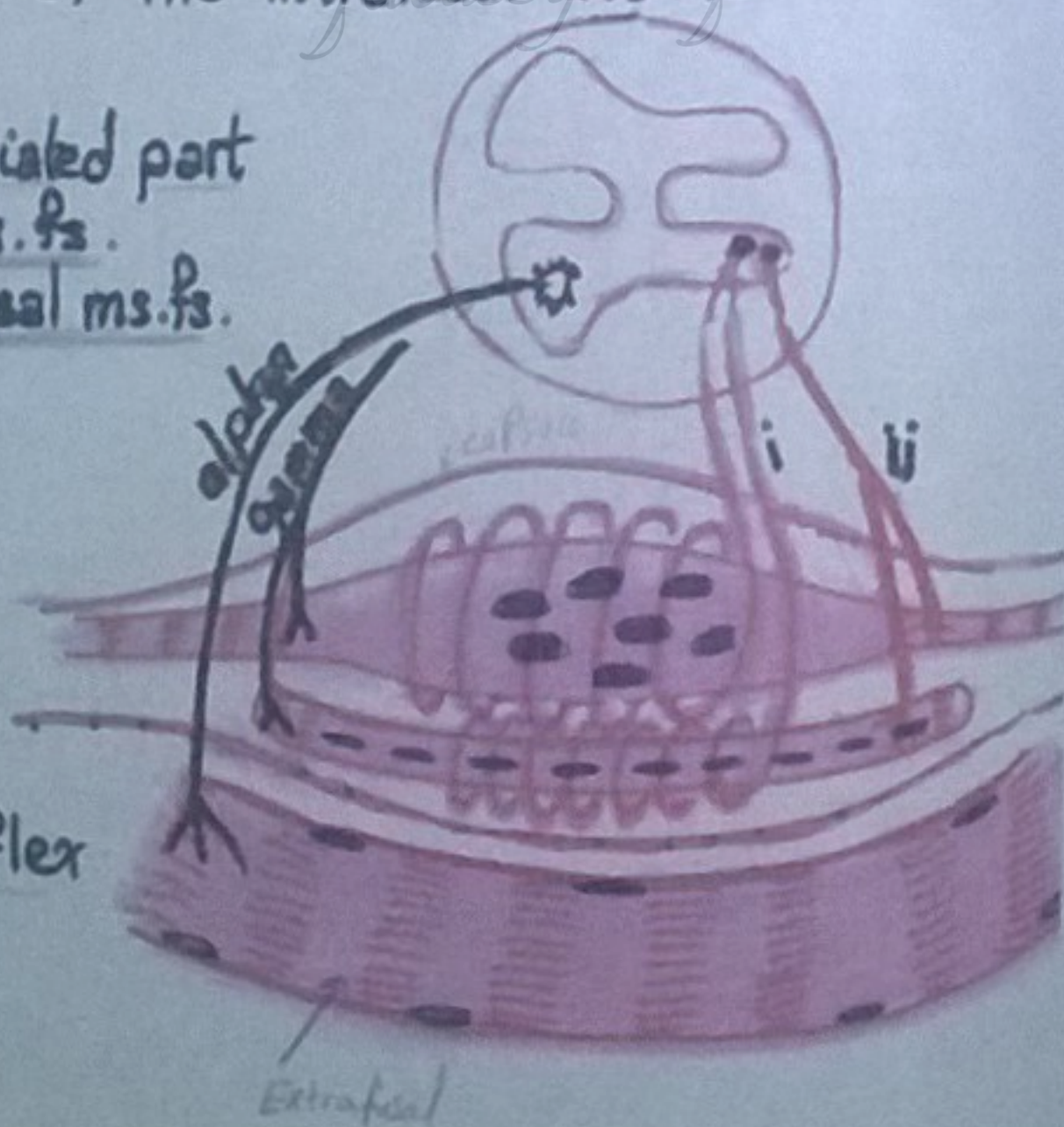
Alpha motor n. fs: innervate the extrafusal ms fs.

Site:

- numerous in
 - antigravity muscles.
 - ms involved in fine movements e.g. intrinsic ms of hand.

- Function: proprioceptors:

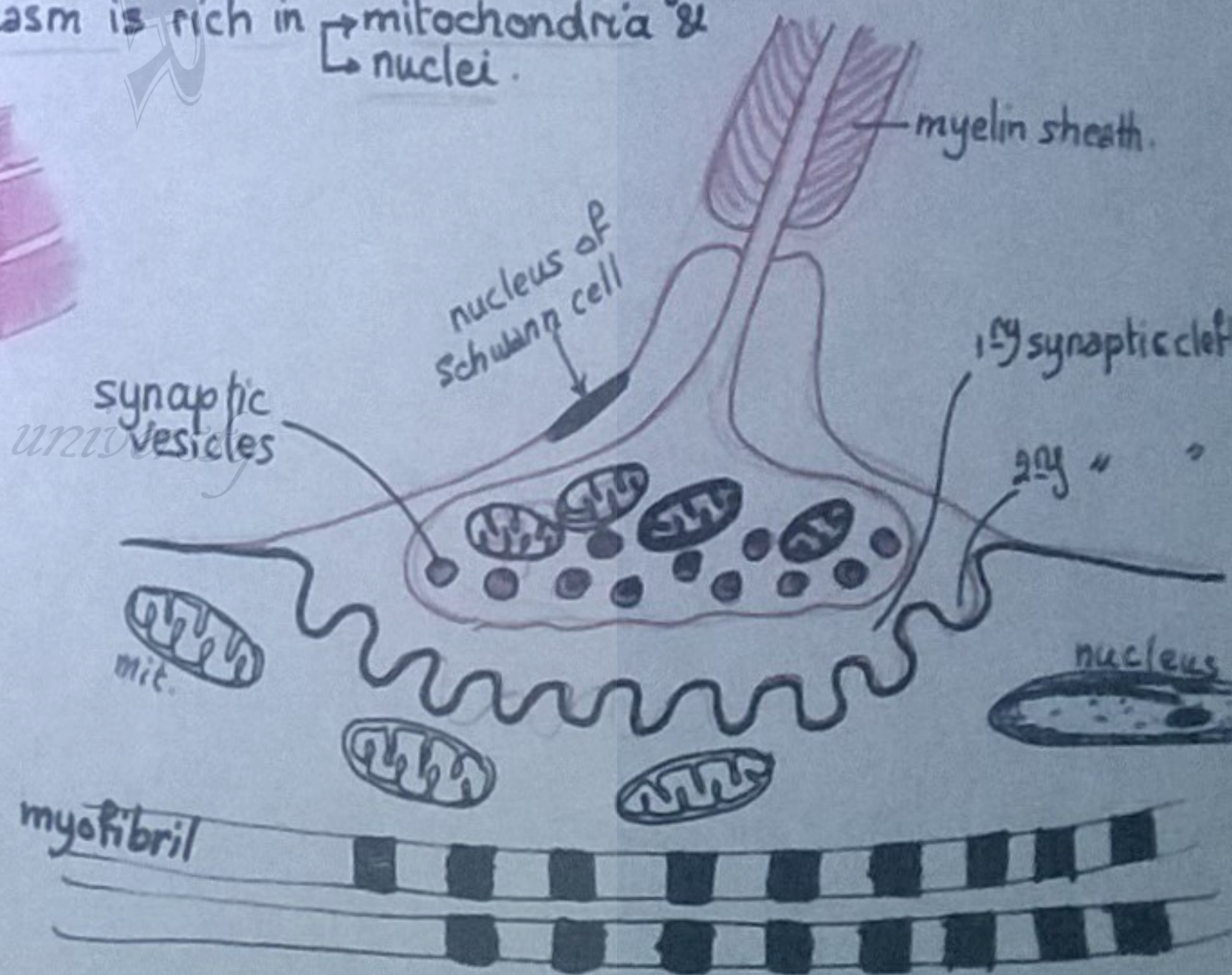
1. regulate ms. tone through stretch reflex
2. Control body posture.
3. Coordinate opposing muscles.



B] Effector:

Motor end Plate [Neuromuscular Junction]

- The termination of motor nerve on skeletal muscle.
- As the motor nerve reaches the muscle, it gives many branches to supply many ms. fs.
- As the single n. f. reaches the muscle fibre, it loses its myelin sheath & the neurolemma gradually fuses e' sarcolemma.
- the expanded end of the axon = axon terminal rich in mitochondria & synaptic vesicles rich in Acetyl choline.
- the space bet. the n. fibre & sarcolemma = 1.5µm Synaptic cleft
- the sole plate = the underlying depression in sarcolemma & sarcoplasm
- It shows the following:
 - the post synaptic memb. is folded = 2.5µm synaptic clefts.
 - the sarcoplasm is rich in mitochondria & nuclei.



Large elastic arteries

e.g. **Aorta**

large branches ^{Subclavian art. 1.}
pulmonary
innominate

- Have thick wall, yellow in fresh section. (mainly formed of elastic fs.)
- Have wide lumen. Formed of: Tunica → Layer

I. Tunica Intima: (10%)

- Endothelium: s.sq. epith.
- subendothelial c.t. rich in elastic fibres.
- undifferentiated int. elastic lamina as it is similar to elastic laminae of tunica media.

II. Tunica Media: [70% of the wall]

- = 40-70 laminae of fenestrated elastic membranes (↑↑ e' age)
- Fenestrae facilitate diffusion of substances through the arterial wall.
- + Circular smooth muscles w produce the elastic fibres & ground subs.
- + collagen " + Undifferentiated Ext.

III. Tunica adventitia: [20%]

- thin = loose c.t. & contains: longitudinal collagen fibres + elastic fibres +
- Vasa Vasora + nerves & lymph vessels.

N.B. During Systole, large elastic arteries distend while during diastole, their elastic recoil → regains their original size & push bl. to smaller arteries

Med. Sized artery:

I. Tunica Intima: thin, formed of:

- Endothelium:
- Subendothelial c.t: thin
- Int. elastic lamina: prominent. In H&E → pink wavy refractile line
so tunica intima appears folded.

II. Tunica Media: (thick)

- = 4-40 layer of circular smooth muscles e' scattered elastic & collagen fibres in between them
- Ext. elastic lamina may be present bet. T. media & adv. in some arteries

III. Tunica Adventitia: Thin

- = longitudinal collagen & elastic fs. + fibroblasts + ns & lymph vs +

Large Elastic Artery	Med. sized Muscular artery
site - Aorta & its branches e.g. pulmonary	- most muscular & organ as
T. Intima - Thicker undifferentiated int. elastic l.	- thinner prominent IEL.
T. media - mainly elastic laminae e' smooth muscles in bet. undifferentiated Ext. Elastic l.	- mainly smooth ms e' elastic & collagen fs in bet. prom. E.E.L. in some arteries
T. adventitia - presence of Vasa Vasora	

Med. sized artery	Med. sized vein
1. Thick wall & narrow lumen	- Thin wall & wide lumen
2. rounded lumen & do not collapse	- flat lumen & collapse after death
3. No valves	- Have valves.
4. No bl. after death.	- contains bl. after death.
5. T. intima: <u>thick</u> , folded, rich in elastic fs + clear int. E. lamina.	- <u>thin</u> , not folded, poor in elastic fs no int. elastic lamina.
6. T. Media: <u>thick</u> , rich in elastic fs.	- <u>thin</u> = sm.ms, poor in elastic fs.
7. Ext. elastic lamina may be present	- No ext. elastic lamina.
8. T. Adventitia: <u>thin</u> , rich in elastic fs	- <u>thick</u> , rich in collagen fs.
9. Has rapid flow of arterial bl.	- slow flow of venous blood

Specialized Med. sized arteries:

Normal — Intima thin
media thick
adventitia thin

	basilar art.	Coronary a.	Umbilical a.
T. Intima	thick, prominent Int. elastic lamina	thick, contains: long. smooth ms, elastic fibres & fat droplets. IEL: present.	No int. elastic Lamina.
T. Media	<u>Thin</u> .	<u>Thick</u>	- Contains: Inn. ^{irreg} circ & out. long. sm.ms.
T. adv.	<u>Thin</u> .	Ext. elastic lamina separates it from T. media	= Mucoid c.t.

Small arteries = Arterioles

< 100 μ m in diameter. gradually $\downarrow$ in diameter if < 50 μ m = Terminal arterioles

→ control bl. flow to capillaries

→ responsible for peripheral resistance of bl. vs. Formed of:

T. intima: v. thin e' thin IEL w gradually disappears in smaller arterioles

T. media: 1 or 2 layers of sm.ms " " " " & replaced by pericytes

T. adv. : v. thin

Metarterioles:

= lat. branches of terminal arterioles = connections bet. arterioles & capillaries.
surrounded by rings of sm.ms w act as sphincters to control blood supply to the capillaries.

Veins

1] Small veins = Venules into w capillaries drain : = [post capillary Venules]

Very thin walled [20-30 μ m] in diameter

T. intima: endoth. resting on thin b.m.

T. Media: = pericytes. & as the diameter $\uparrow$, smooth ms start to appear

T. adv.: (thick)

(N.B) Exchange of materials bet. bl. & tissues occurs in $\rightarrow$ capillaries & post cap. venules.

2] Med. sized veins [muscular]:

T. intima: endoth, subendoth c.t. (thin) e' no int. elastic L.

T. media: circular sm.ms. + longitudinal collagen fs, fibrobl. few elastic fibres

T. adv. (thick) = loose c.t. rich in collagen fs.

(N.B) Valves = folds projecting from T. intima formed of elastic c.t. covered e' s.sq. endothelium.

Valves are absent in $\rightarrow$ Sup. Vena Cava, cerebral vein
 $\rightarrow$ umbilical vein.

3] Large Veins: e.g. inf. Vena Cava:

Have thick wall & wide lumen

T. intima: no IEL, Have valves.

T. media: (thin)

T. adventitia: (thick) = loose c.t. contains long. smooth ms & elastic fs for easy elongation & shortening of I.V.C. e' respiration.

* Vasa Vasora as bl. passing through them has a low O_2 tension.

Arterio-Venous Connections [Peripheral Circulation]

SQ
- 4 -

I Blood Capillaries

Narrow vessels formed by rolling of an endothelial cell.

length about 50 μm • diameter 8-10 μm • Origin: UMC.

Structure: ^{Single} 1 layer of endothelial cells joined by tight junction & rest on a basement memb. w splits to enclose pericytes → contain contractile filaments (actin, myosin & tropomyosin) → media of capillaries their contraction → vasoconstriction.
→ can differentiate into → endothelial cells, fibroblasts, smooth ms. on injury.

Types of Capillaries:

(1) Continuous [Somatic]

Have no pores

Sites: All over the body e.g. c.t.

Brain, bone, skeletal ms, skin
lungs, & exocrine glands.

Structure: continuous endoth. w rests on " " b.m.

(N.B) Brain capillaries: [Bl. Brain Barrier]

Have continuous endoth. (cells are joined by tight junction)

Have thick b.m. & wrapped by processes of astrocytes.

(2) Fenestrated [Viscera]

Have pores

- At site of rapid exchange → intestine: for absorption.
→ Kidney: filter blood.
→ endocrine glands: carry hormones.

- fenestrated endoth. (e' pores) on

- thin continuous b.m.

the pores are covered e' diaphragms except in renal capillaries.
(thinner than cell memb.)

(3) Sinusoidal Capillaries: [Bl. sinusoids]

- wide irregular bl. vessels (30-40 μm) - lined e' fenestrated endothelium resting on.
- non-continuous b.m. e' large intercellular gaps.
- Macrophages extend pseudopodia bet. the cells to phagocytose any foreign body in blood.

Sites: 1. Spleen: to carry stored bl. to circ (on need) & filter bl. (by macrophages)

2. Bone marrow: carry formed bl. cells to circ.

3. Liver: to carry plasma ptn. to the blood.

SQ

arterioles and venules.

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II Arterio-Venous Anastomoses [Shunts]

Def: := direct connections bet. arteries & veins not passing through capillaries to allow rapid circulation of bl. to certain areas

- When the AVA is closed bl. passes to the capillaries but
- " " " " opened bl. bypasses " " → rapid circ.

Structure: (types)

1] **Simple:** side branch:

- similar to artery at the arterial side & similar to vein & venous side
- the intermediate segment has:
 - thickened tunica media.
 - subendoth. c.t. contains longitudinal smooth muscles.

2] **Complex Connections [Glomus]** covered e' c.t. capsule:

After the arteriole penetrates the capsule, it becomes convoluted, loses IEL & the lumen becomes surrounded by richly innervated smooth muscles.

Sites:

• **Exposed parts of body:**

e.g. ext. ear, tip of nose, tips of fingers & toes, lips & eye lids.

• **Internal organs:**

e.g. uterus, penis, placenta, thyroid gland. (GIT)

Functions:

1. **Regulate body temp:** in skin: they dilate in cold & constrict in hot weather.

2. **Regulate venous return.**

3. **Regulate bl. flow** to genital organs.

4. " " " " organs during digestion, absorption & secretion

Lymphatic System

Lymph Vessels:

tissue fluid (from bl. capillaries) pass to blind ended lymphatic capillaries
w join → larger vessels.

* No lymph vessels in Brain & bone marrow, Cartilage & Cornea & Thymus.

Lymphatic capillaries:

differ from bl. capillaries in: - ¹start e' a blind end, ²larger & ³more permeable
- ⁴Non-penestrated endoth. but ⁵wide gaps bet. endothelial cells e' ⁶no tight junctions - ⁷Interrupted b.m.

- Functions: 1. returns lymph to blood.

2. the gaps bet. endothelial cells & the interrupted b.m. help to remove large molecules as plns, fat droplets & bact. w cannot be carried by bl. capillaries.

Small & Med. Sized lymph vessels:

Similar to venules but:

- Have thinner wall, ¹larger diameter & ³wider lumen & ⁴more
- bicuspid valves (Flow in 1 direction) → ⁵beaded appearance
- T. Media has long. & circ. smooth ms.

Lymph ducts:

Similar to large veins but:

- T. Media: long. & circ sm. ms + elastic fibres.
- Adventitia: have long. sm. ms + Vasa Vasora.

Lymphatic tissue

= lymph follicles (nodules) + diffuse lymphocytes.

Lymphatic Organs: → 1st [central] = Bone Marrow, Thymus.

→ 2nd [peripheral]

- [Lymph Node
- [Spleen
- [Tonsil
- [MALT

mucosa associated
lymphatic tissue

Lymph Node

def.: encapsulated kidney shaped lymphatic organs along the course of lymph vessels to filter lymph from any organism.

Site: in groups all over the body e.g. neck, axilla, groin, thorax & abdomen

Structure:

Stroma:

- Capsule** := dense c.t. [cells [mainly fibroblasts] fibres [collagenous & elastic] . Thin
- thickened only at the hilum due to presence of smooth muscles.
- covered e' adipose c.t.
- Trabeculae** := c.t. septa = c.t. [cells & fibres]
- descend from the deep surface of the capsule to divide the cortex into regular compartments. In the medulla, they branch to divide it into irregular compartments.
- Reticular c.t.** = formed of reticular cells & fibres. In the background stains brown e' Ag. • Condensed at the follicles.

Parenchyma:

1. Cortex: Formed of:

(a) **Cortical lymph follicles [nodules]:**

• **1st lymph follicles:**

- rounded, oval or pyramidal = aggregations of small lymphocytes mainly B, few T-lymphocytes + antigen presenting cells + reticular cells.
- When exposed to specific antigen, some of the lymphocytes will become activated [large lymphocytes] & collect in the centre to form pale germinal centre & change into →

• **2nd lymph follicles:**

follicles e' dark peripheral part of small lymphocytes e' dark nuclei & pale germinal centre containing large activated B-lymphocytes, lymphoblasts, plasmablasts, plasma cells, some T-lymphocytes, macrophages & reticular cells.

(b) **Thymus dependant Zone = Paracortex**

= the deep part of the cortex [bet. cortex & medulla], contains

T-lymphocytes w have migrated from the thymus through post-capillary venules, lined e' s. cubical epithelium.

⑤ Cells - 2

C - Cortical Lymph Sinuses:

The spaces bet. cortical follicles & capsule & trabeculae subdivided into subcapsular & trabecular sinuses lined e' endothelial cells & macrophages. Contain β -lymphocytes, plasma cells & macrophages.

2 Medulla: formed of:

a - Medullary Cords:

- irregular aggregations of B-lymphocytes, plasmablasts & plasma cells.
- may be continuous w' the cortical follicles.

b - Medullary sinuses:

- spaces bet. med. cords & trabeculae. lined e' endothelial cells & macrophages.
- contain lymph received from the cortical sinuses.

Circulation of Lymph

aff. lymph vessels enter through the outer convex border (have valves to allow lymph to move in one direction) & pour into the cortical ^{sinuses} then the medullary sinuses & drain into efferent lymph vs w' come out from the hilum.

Blood Supply

Arteries enter from the hilum & their branches give capillaries to supply the cortex.
→ post-capillary venules → veins that leave at the hilum.

Cells in Lymph Node

Stromal cells: Fibroblasts & reticular cells.

Parenchymal cells: β -lymphocytes: in cortex & medulla.

- activated lymphocytes + plasmablasts & lymphoblasts in the germinal centre.
- plasma cells & macrophages.
- T-lymphocytes in the thymus dependent zone.
- endothelial cells lining the sinuses. (simple cubical cells)

Functions of Lymph Node

1. Filtration of lymph from any organism: by macrophages.
2. Formation of lymphocytes: in the germinal centre.
3. Immunological function:

(a) Humoral Immunity: β -lymphocyte are activated by T-helper cells → plasmablasts → plasma cells w' secrete antibodies.

(b) Cell Mediated Immunity: direct destruction of bacteria.
Also T-Killer cells secrete lymphokines to destroy the antigen.

The Spleen

def. Single, intra-abdominal hemolymphatic organ, along the course of blood to filter blood from any organism.

Structure

Stroma:

- 1. Capsule: formed of c.t.
 - cells: mainly fibroblasts
 - Fibres: collagenous & elastic
- 2. Trabeculae: " " "
 - cells - Thick, rich in smooth ms. carry bl. vs & nerves
 - fs
 - * few descend from the capsule but they mainly arise from the hilum.
 - * divide the spleen into irregular compartments.
- 3. Ret. c.t.: ret. cells & fibres in the background. stained e' Ag.
 - condensed at white pulps.

Parenchyma:

In fresh sections: it shows white spots on red background i.e. divided into:

1. White Pulp [Malpighian Corpuscles]

Rounded or oval, scattered follicles e' an arteriole on one side = central arteriole or follicular arteriole. Formed of reticular c.t. on w cells are arranged in 4 concentric zones around the arteriole:

- (a) Thymus dependent Zone = Peri-arteriolar Lymphatic Sheath [PALS]
Contain T-lymphocytes w ensheath the arteriole. (4 cells)
- (b) Germinal Centre: pale area, contains activated large B-lymphocytes, plasmablasts, plasma cells & macrophages.
- (c) Follicular Zone = Corona = dark, contains B-lymphocytes. (4 cells)
- (d) Marginal Zone: at the periphery, contain T. & B-lymphocytes, plasma cells & macrophages.

2. Red Pulp appears red in fresh section (large No of RBCs). formed of:

- (a) Splenic Cords: Billroth Cords.
the areas bet. the white pulps & bl. sinusoids, contain bl. cells [RBCs, granular WBCs + lymphocytes & monocytes] + plasma cells & Macrophages. (6 cells)
- (b) Blood Sinusoids:

Wide irregular bl. spaces lined e' elongated fenestrated endothelial cells e' non-continuous basement membrane for easy passage of bl. cells to blood. Macrophages appear in the wall of the sinusoid to engulf any foreign body.

Lymph Node	Spleen
No. & Site - multiple, small - along the course of lymph vs.	- single & large. - intra abdominal.
Functions - Filter lymph - Humoral & cellular immunity	- filter & stores blood. - Immune functions.
Capsule : thin, covered e' fascia (fat) - smooth ms only at the hilum - have afferent & efferent lymph vs.	- thick, covered e' peritoneum. - rich in smooth ms - No afferent lymph vessels.
Trabeculae : thin, descend from the capsule	thick, mainly arise from the hilum
Parenchyma: Cortex & Medulla Cortex = regular [Cortical follicles + sinuses] (Thymus dependent zone) - Follicles have clear germinal centre but <u>no</u> central arteriole Medulla → medullary cords & sinuses → " " sinuses	- White pulp & red pulp. White pulps: scattered - No sinuses. - Have central arteriole. Red pulp → splenic cords & bl. sinusoids → bl. sinusoids
Cells : → lymphocytes → plasma cells & → macrophages	→ RBCs, WBCs → plasma cells → macrophages.

Clinical Notes:

Lymphadenitis: enlarged & inflammed lymph Nodes draining infected area.

Carcinoma: spread from the 1st site through lymphatics to the regional lymph nodes w become enlarged. so they are usually removed during surgical excision of the cancer.

∴ Examination of lymph Nodes gives information about cancer spread

The Thymus Gland

def: It is a primary lymphatic organ & also has an endocrine function.

Site: present behind the sternum. ↑ in size from 2nd year of life & involutes after puberty.

Origin: double origin: lymphocytes (mesodermal) & epith. reticular cells (endodermal)

Structure:

A. Stroma:

- **Capsule:** c.t. < , thin.
- **Trabeculae:** subdivide the 2 lobes into incomplete lobules.
- **Reticular stroma:** reticular cells & no fibres. in the background. secrete hormones

B. Parenchyma:

each lobule has outer dark cortex & inner pale medulla:

1. The Cortex:

It appears darker than the medulla as it is more populated w/ lymphocytes. Its outer part contains lymphoblasts & the inner part contains lymphocytes (thymocytes) surrounded by epith. reticular cells + macrophages.

2. The Medulla:

The medullae of adjacent lobules are continuous. They appear lighter than the cortex as they have less lymphocytes & more epith. reticular cells. They contain acidophilic structures called Hassall's Corpuscles.

Hassall's Corpuscles:

= central acidophilic masses of degenerated epith. reticular cells surrounded by concentric layers of epith. ret. cells. in the medulla, ↑ w/ age.

The Main Cells present in the Cortex & medulla:

1. Epithelial reticular cells:

Origin: endodermal. **basophilic cytoplasm & large pale oval N & prominent nucleus**

L.M.: branched cells & **E.M.:** have secretory granules, their long processes contain tonofilaments & joined by desmosomes.

Functions:

1. Form sheets under the capsule, around the septa & bl. v.s to isolate & protect cortical lymphocytes from any circulating antigen while they are programmed.
2. secrete thymic hormones & factors to promote differentiatⁿ & proliferatⁿ of lymphocytes.

2. T-lymphocytes:

- **Origin:** mesodermal.
- Stem cells in b.m. migrate to the thymus & give lymphoblasts in the outer part of the cortex where they divide & give lymphocytes w/ acquire the ability to recognize diff. antigens (thymic education).
- lymphocytes w/ can react against the body's own ptn are phagocytosed & destroyed by macrophages. - Mature lymphocytes pass to deep part of cortex then to medulla → enter blood → 2-4 lymphatic organs [lymph nodes, spleen]

Where they settle down in the thymus dependent zones.

- 8 -

3. Macrophages:

around thymocytes to phagocytose degenerating thymocytes & any antigen escaping from the barrier.

Blood thymic barrier -

= the wall w separates newly formed T-lymphocytes in cortex of thymus from any circulating antigen. Formed of:

- ① Continuous endothelium of the capillaries.
- ② thick continuous basement memb. of the capillaries.
- ③ perivascular c.t. containing macrophages to phagocytose any Ag that escape from the cap.
- ④ epith. reticular cells

Functions:

protect immature T-lymphocyte (in cortex) from any circulating antigen. untill they migrate to the medulla & enter the blood.

N.B. the medulla has no barrier.

absence of aff. lymph vessels protect it from any circulating antigen

Special Features of the Thymus

1. It undergoes atrophy at puberty.
2. Its reticular cells are endodermal & do not form reticular fibres.
3. It has no B-lymphocytes, no plasma cells, no lymph nodules, no aff. lymph vessels
4. Contains Hassall's Corpuscles.

Functions of the thymus:

1. Proliferation & differentiation of T-Lymphocytes:

2. Secretion of thymic hormones: by epith. reticular cells w stimulate maturation & activity of T-lymphocytes. The hormones are:

- (a) Thymic humoral factor: stimulate mitosis of T-helper & T-suppressor cells.
- (b) Thymopoietin: stim production of T-cytotoxic cells.
- (c) Thymosin: " " " lymphocytes.
- (d) Thymulin: " function of T-lymphocytes (esp) T-suppressor cells.

The Tonsil

def.: partially capsulated lymphatic tissue, 3 sites:

1) Palatine Tonsils:

2 oval masses of lymphatic tissue under the mucous memb. of oropharynx.

Structure:

- lymphatic tissue → lymph follicles: e' or ebut germinal centre + diffuse lymphatic tissue = lymphocytes + plasma cells + Macrophages
 - Covered by non-keratinized st. sq. epith w dips into the lymphatic tissue forming crypts in w bact, lymphocytes & macrophages may accumulate.
 - dense c.t. → incomplete capsule w separate it from the adjacent structure
 - mucous glands deep to the follicles: their ducts open on the surface & not in the base of the crypt so inflammation is common.
- N.B: Salivary Corpuscles = lymphocytes w penetrate the epith. to appear in the saliva.
 have migrated from Tonsil

2) Lingual Tonsils:

- at the base of the tongue
- formed of lymphatic tissue in the form of follicles & diffuse lymph. tissue.
- Covered e' non-keratinized st. sq. epith w dips down to form crypts.
- Mucous glands open into the base of the crypt → continuous washing, so inflammation is uncommon.

3) Pharyngeal Tonsil:

- lymphatic tissue (single mass) under the mucous memb. of the nasopharynx
- covered e' pseudostratified columnar ciliated epith. e' goblet cells w is folded
- e' no crypts. Hypertrophy is called adenoids.
 الحية

Functions of Tonsils:

protection of the respiratory & digestive systems from any invaders by production of antibodies.

Clinical Note:

Tonsillitis: infection of the palatine tonsil → sore throat.
 repeated infection → enlarged & become focus of infection, so must be removed surgically [tonsillectomy].

Macrophage System

[mononuclear phagocytic system]

Reticulo-endothelial system

def.: phagocytic cells all over the body for defense. Reticular cells & endothelial cells were thought to be phagocytic.

Stain: when a vital stain e.g. trypan blue or Indian ink is injected into an animal, macrophages engulf the dye & can be seen as granules by L.M.

Origin: blood monocytes. (mesodermal in origin)

Histological characters:

- have irregular surface [indentations] & receptors for Igs.
- have oval or kidney-shaped eccentric nucleus.
- prominent rER, well developed G.A, many lysosomes & residual bodies.

Functions of phagocytic cells:

1. phagocytosis of any bact. or debris (dead cells).
2. Cleaning of wounds, so help healing.
3. destruction of old RBCs, storage of iron & production of bile.
4. Antigen presenting cells, so have imp. role in immunity.

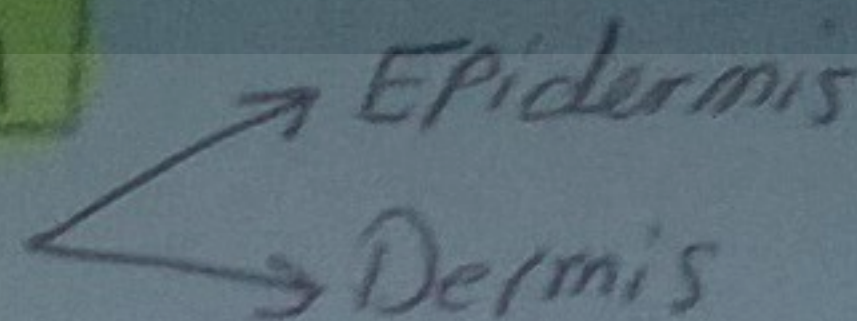
Distribution:	Site	Cell type
1. Blood.		- monocytes.
2. Blood sinusoids of spleen & b.m.		- Littoral cells.
3. Blood sinusoids of Liver.		- Von Kupffer cells.
4. Brain (CNS).		- Microglia (Mesoglia)
5. C.T. + Stroma of: [lymph node, spleen & b.m.]		- Macrophages. <i>histiocyte</i>
6. Lung alveoli.		- Dust cells & heart failure cells.
7. Skin.	& Thymus	- Langerhans cells.

(N.B) Antigen presenting cells [APC]:

- derived from the b.m.
- belong to the immune system.
- they endocytose the antigens, digest them $\rightarrow$ small peptides that form complexes & molecules on their cell membranes & present them to T-lymphocytes.
- They include: macrophages, M-cells, Langerhans cells of the skin, dendritic cells & epithelial reticular cells of the thymus

Thick Skin

Present in palms & soles. Formed of:



I. Epidermis

= Keratinized str. sq. epith. formed of Keratinocytes & Non-Keratinocytes.

[A] - Keratinocytes

85% of cells of epidermis, form Keratin. 5 layers:

1. **Basal Cell layer** = **Stratum basale** = **germinal L.** deepest layer.

L.M. 1 layer of Columnar cells, resting on a clear & wavy basement memb.
- Have basal oval nuclei w show mitotic figures for renewal w takes place every 2-4 weeks mostly at night. & basophilic cytoplasm
- Melanocytes + Merkel's cells are present in this layer.

E.M. Cells are joined together by desmosomes & to b.m. by hemidesmosomes.
- rich in ribosomes & polysomes - have intermediate filaments = Tonofilaments
- Cells show Few GA, few mit. and few r.E.
- prekeratin in bundles w end in desmosomes.

2. **Spinous layer** = **Str. spinosum** = **Prickle cell L.**

L.M. 4-8 layers of polyhedral cells w central rounded nuclei w show mitotic figures & less basophilic cytoplasm. They have spine-like processes indicating sites of desmosomes as cells shrink during preparation
- Langerhan's cells are present in this layer.

E.M. Tonofilaments in bundles w end in desmosomes + interdigitating cell membs.
- the superficial cells contain membrane bound (coated) lamellar granules.

(N.B) **Malpighian layer** includes basal L layer + spinous layer.

3. **Granular layer** = **Str. granulosum**:

L.M. 3-4 layers of spindle-shaped cells w flat nuclei & basophilic granules.

E.M. 2 types of granules:

(a) **Coated lamellar granules**:

Oval or rod-shaped, covered by membs, contain lamellar discs = lipid bilayer
F: they discharge their content to intercellular space & top layer to form lipid sheets to act as cement (sealing effect) & act as barrier.

(b) **Keratohyaline granules**:

large bodies (not) covered by membs, contain ptns w many phosphate groups so basophilic by L.H. F. form matrix w bind tonofilaments $\Rightarrow$ bundles.

4. Clear Layer = Str. Lucidum

L.M. thin, homogenous clear layer = flattened cells, Nuclei start to disappear

E.M. Have thick cell membs. joined by remnants of desmosomes.

- Nucleus & organelles disappear [lysosomal activity].
- Contain filaments of eleidin = immature Keratin embedded in the matrix formed by the Kerato-hyaline granules.

5. Horny layer = Str. Corneum:

L.M. Acidophilic scales of dead Keratinized cells.

E.M. Have thick cell membranes & joined by remnants of desmosomes.

- Have no nuclei or organelles.
- Bags filled w/ mature Keratin filaments embedded in amorphous matrix.

[B] Non-Keratinocytes

1. Melanocytes:

Origin: ectodermal. in Basal cell layer

L.M.: have rounded cell bodies & pale rounded nuclei. Cannot be seen by H&E.

- have long processes w/ extend bet. Keratinocytes. The tips of their processes end in invaginations in cells of Malpighian layer. Give Dopa +ve reaction.

E.M. Have euchromatic nucleus & prominent nucleolus. basophilic cytoplasm.

- characters of ptn. forming cells i.e. many mit., rER & well developed G.A.
- No desmosomes bet them & Keratinocytes but joined to b.m. by hemidesmosomes (basal lamina)
- have intermediate filaments (10 nm) * granules known as melanosomes

Functions:

1. form tyrosinase enzyme essential for melanin formation.
2. melanin granules lie above the nucleus to protect DNA from UVRs of Sun by scattering.

(N.B.) Dopa Reaction:

When section of skin is incubated w/ DOPA. Tyrosinase in melanocytes convert DOPA into melanin. Importance: to distinguish bet. melanocytes & melanophores.

↳ count melanocytes / area of skin.

2. Merkel's Cells:

in Basal cell layer

Origin: ectodermal.

L.M. modified basal cells. Naked sensory nerve fibres end in disc like expansion under these cells → Merkel cell-neurite complex.

E.M. attached to adjacent cells by desmosomes - Invaginated Nucleus.
- cytoplasm contains → electron-dense granules like neuro-endocrine cells [APUD].
↳ cytoKeratin filament (differ from those of Keratinocytes).

Functions: 1. mechanoreceptor for press.

2. granules → paracrine regulation of epidermal cells.

3. Langerhans Cells (3-8% of epid. cells)

Origin: mesodermal

L.M. stellate cells bet. cells of spinous layer

have dark N. & pale cytoplasm.

stained by supravital stain [methylene blue].

E.M. 1ry & 2ry lysosomes + well developed G.A.

- Birbeck's granules = tennis-raquet-shaped e' Non-clear function may contain hydrolytic enzs / Irregular Nucleus

- No melanin granules, No Keratin, No desmosomes & no junctions e' Keratinocytes.

Function: 1. Act as antigen presenting cells: present antigens w contact skin to T-cells so play a role in allergic or immunological reactions.
2. may control cell division in epidermis.

II Dermis

C.T. under epidermis = 2 layers.

Papillary layer	Reticular layer
- thinner & superficial.	- thicker & deeper.
- formed of loose c.t.	- dense c.t.
- more cellular ↳ Fibroblasts + fat cells ↳ macrophages + mast cells ↳ lymphocytes.	- less cellular
- fine c.t. fibres ↳ type III collagen ↳ elastic fibres	- collagenous bundles [type I collagen] ↳ elastic fibres.
- More vascular	- less vascular
- Receptors: Meissner's Corpuscles	- Pacinian Corpuscles + Krause end bulb + Ruffini end Organ

Factors fixing epidermis to dermis:

- ① basement memb. of epidermis.
- ② hemidesmosomes bet. basal cells & b.m.
- ③ dermal papillae interdigitating e' epidermal ridges.

Color of Skin: depends on:

1. Hb in bl. caps of skin (red) → in dermis
2. Carotene content. (yellow)
3. Melanin pig. (brown to black)

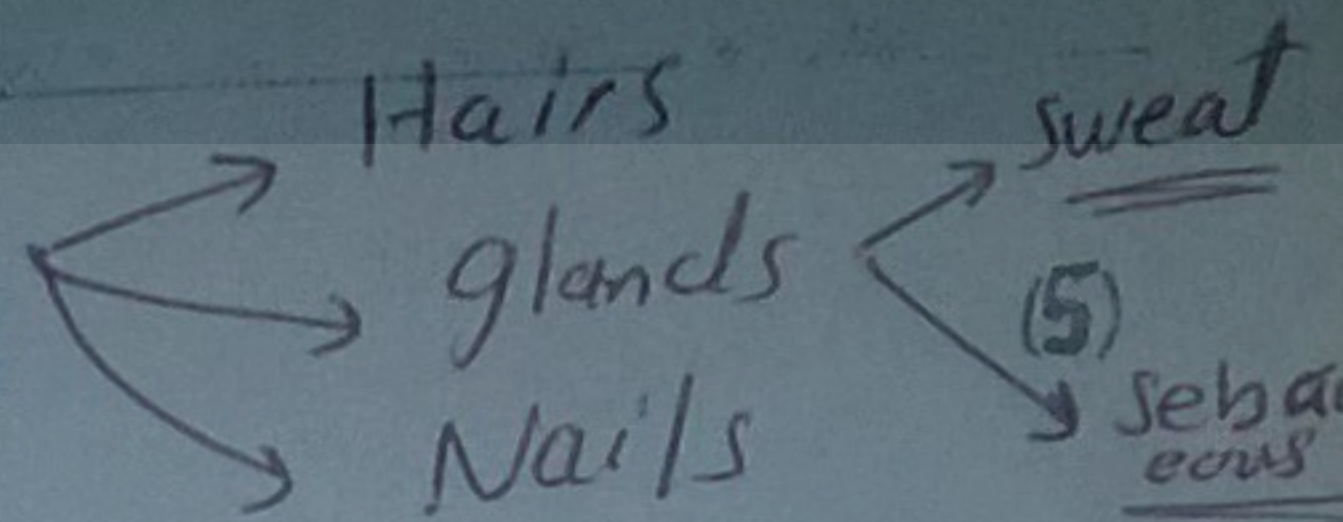
Thick skin	Thin skin.
Sites :- Palms & soles - tips & sides of fingers & toes	- the rest of body.
Epidermis - thick - thicker Malpighian L. - thicker Granular L (2-4 Ls) - Clear L: present - thick Horny L.	- thinner. - thinner. - thinner (1 L) - absent - thinner.
dermal papillae - regular, numerous, high	- few, irregular
Appendages hair follicles } absent erector pili ms } sebaceous gls. } More numerous sweat gls	- present. - less numerous.

N.B. the thinnest skin in our body is in eye lid.

Functions of skin:

- ① protection: act as barrier against trauma, infection, dehydration. (by melanin)
- ② sensory organs (receptors)
- ③ regulate body temp. (sweat + A-V. shunts)
- ④ excrete waste products + H₂O (sweat gls)
- ⑤ synthesis of vit. D.
- ⑥ medico-legal (finger prints)
- ⑦ diagnosis of some diseases e.g. measles, chicken pox, anemia, jaundice, cirrhosis.

Skin Appendages



A. Hairs

def: Keratinized oblique epithelial thread inserted into epidermal sheath = hair follicle.

Structure: modified part of Horny layer. **Formed of:**

① **Shaft:** the part projecting above skin surface.

② **Root:** " " embedded in the " inside the follicle.

both shaft & root are formed of:

a. medulla = Soft Keratin.

b. cortex = hard " contain melanin

c. cuticle = hard

③ **Hair Follicle** = downgrowth of epidermis around the "root" of the hair
formed of 3 sheaths:

* **Inner root sheath:** 3 layers.

- **Cuticle** = scales rich in soft Keratin.

- **Huxley's Layer** = 2-3 layers } rich in trichohyaline granules → soft Keratin

- **Henle's** = 1 Layer

* **Outer root sheath:**

- downward continuation of epidermis

- At bottom = basal layer (only).

* **C.T. sheath:** c.t. dermis.

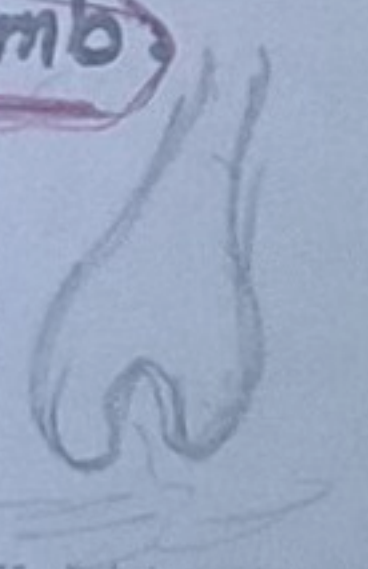
* the outer root sheath is separated from c.t. sheath by thick basal lamina

(N.B.) Hair bulb

= terminal dilatation of the hair follicle

invaginated by vascular c.t. from dermis "hair papilla"

contain melanocytes + matrix cells for growth of hair.



Colour of hair:

caused by melanin pigment in the cortex produced by melanocytes in hair matrix

Grey hair: in old age melanocytes fail to produce tyrosinase.

Yellow hair: due to pheomelanin (yellow)

Baldness: hair loss due to genetic factors & sex hrs. mainly in ♂

Arrector Pili Muscle

smooth muscle: **origin:** papillary layer of dermis. **insert:** c.t. sheath

It's contraction: (fear, cold = symp) → erection of hair, depression of skin (goose)

B Glands of Skin

a. Eccrine sweat gls

Sweat glands

b. Apocrine sweat gls

2 Sebaceous gl.

Type	Simple coiled tubular gland	Simple or s. branched alveolar gl.
Mode of Secretion	- Merocrine (by exocytosis)	- Holocrine: whole cell die & lost e' secretion
Site	All over the body except in glans penis & nail bed more in thick skin.	- associated e' hair follicles. rarely e' but hairs
Acini	Smaller e' narrow lumen lined e' 1 layer of cuboidal cells 2 types (1) Large pale [Clear] cells - more numerous - broad base & narrow apex - pale cytoplasm (glycogen) - intercellular canaliculi present bet them (2) Small dark cells - less - narrow base & broad apex - dark granular Cyt. (glycoprotein)	larger e' wider lumen lined e' surrounded by myoepith. cells 1 or 2 pear-shaped alveoli lined e': - basal flat stem cells to replace - central polyhedral cells e' central nuclei & vacuolated cyt (fat)
Ducts	Spiral course in epidermis & open into epidermis lined e' 2 layers of cuboidal cells in epidermis it is just spaces bet epid. cells	Short, open into upper 1/3 of hair follicle lined e' st. sq. continuous e' the out. root sheath.
Function	Clear watery sweat [H₂O + NaCl + urea + ammonia]	Viscid milky sweat rich in ptn. Odourless bact. decomposition * function at puberty
Nerve supply	cholinergic	Adrenergic
		F. secrete sebum (oily) - prevent cracking of skin - anti bact & anti fungal * disturbed secretion → acne

C. Nails

(7)

def: plates of Keratinized epith. cells on dorsum of distal phalanx.

Comed of: Nail plate + free edge + root (in nail groove, covered by nail fold)

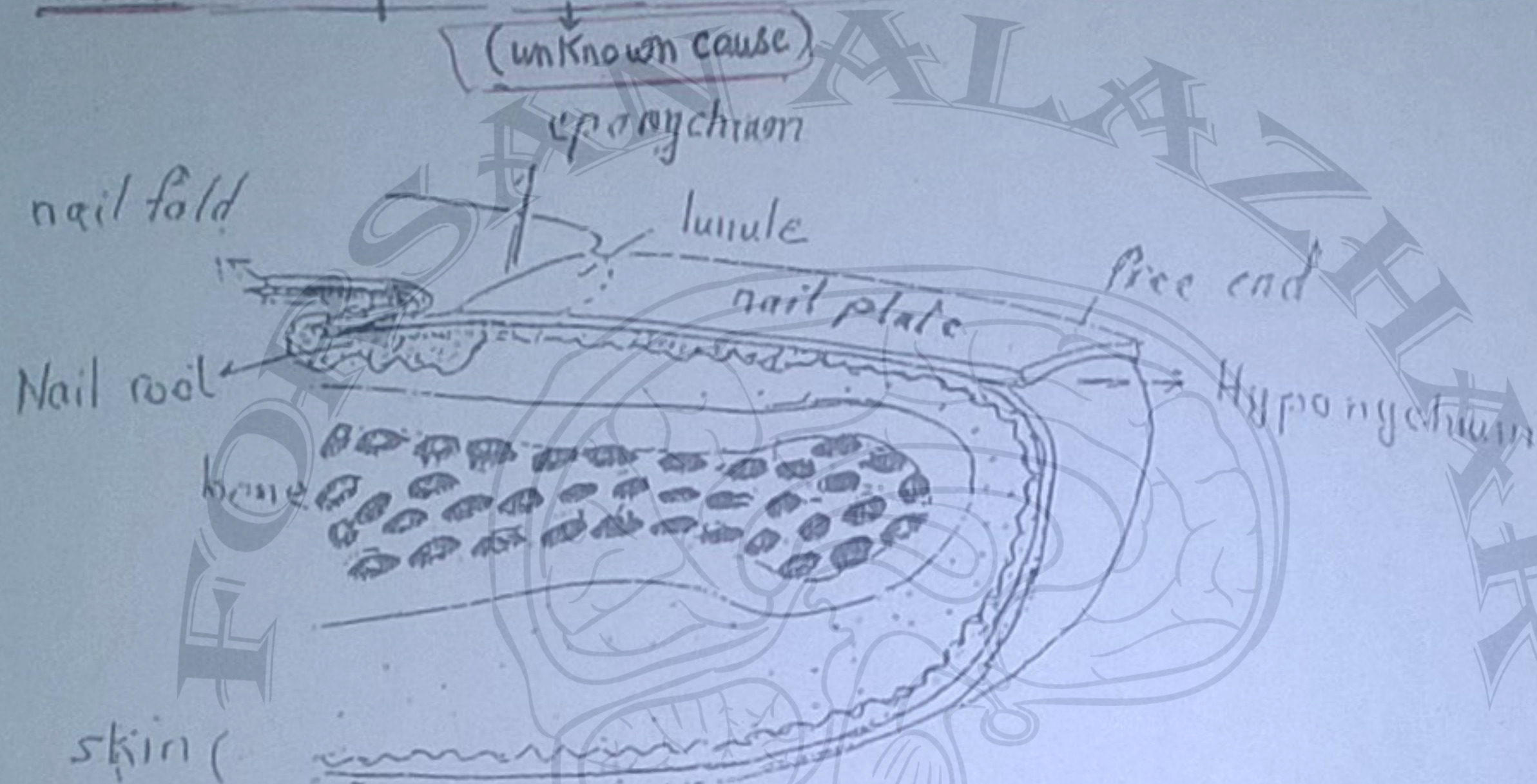
Proximal nail fold: skin fold w covers the root = **eponychium** or cuticle.

Lateral " ": 2 skin folds that cover the lat. sides of the nail.

Nail bed = area under the nail plate $\rightarrow$ epidermal cells = thin **Malpighian L.** ^(sterile) _(matrix)
 $\downarrow$ **dermis** (highly vascular & no papillae)

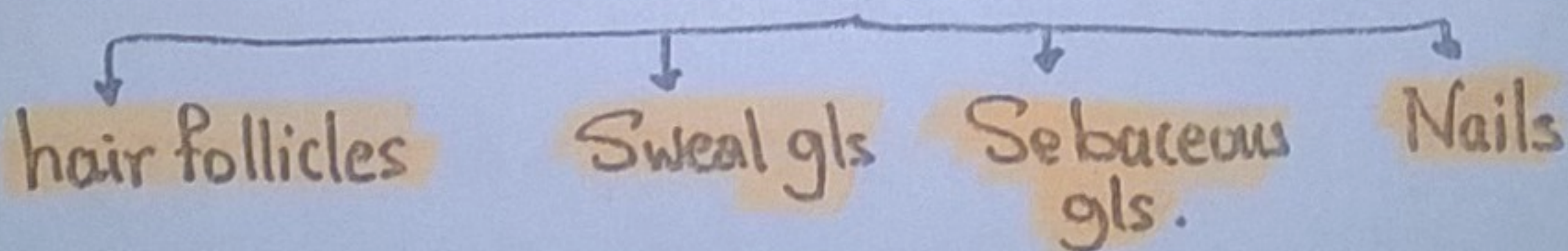
Nail Matrix: Malpighian cells lining the nail groove from w the nail grows.

Lunule: crescent-shaped white area at the base of the nail plate.



الغشاء الكري Nail

Integument = skin + Appendages



تمت بحمد الله

التصوير والتعديل خاص بفورسان الازهار Forsan Alazhar

للمزيد زورو صفحتنا على فيس بوك :

Forsan Alazhar